ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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ENGINEERING NEWS.

THE FIRST SOD OF THE NICARAGUA CANAL was turned on Oct. 22 with no little ceremony and enthusiasm, all difficulties having been adjusted in the Nicaragua-Costa-Rica difficulty, so that there is no longer occasion for delay. A force of 200 laborers with picks, shovels, and wheelbarrows were drawn up in line just out of Greytown, and after the usual brief speeches, by Chief Engineer MENOCAL and Governor DELGODILLO, ground was broken by the laborers, and Mrs. F. A. PEREZ, wife of Resident Engineer PEREZ, trundled off the first barrow-load of earth,—and probably almost the last one for very little of the actual work of excavation will be done in the primitive method which is naturally adopted for the ceremonial start.

WORK ACTUALLY BEGAN, June 3, but pending settlement of the Costa Rica difficulty, formal opening was delayed. In the meantime the work of installation has been pushed vigorously forward, a small town has been built on the seashore near San Juan del Norte, and 27 miles of telegraph and telephone line have been completed in the task of uniting San Juan del Norte with Fort San Carlos, a distance of about 100 miles. Twelve miles of aqueduct is well under way, a mile of railway is nearly completed, and in a few months' time the temporary pier or jetty will be far enough advanced to permit the dredges to start their portion of the work. All looks auspicious for the active prosecution of the work, and it is not unreasonably hoped that the canal may be opened to traffic in 1894.

THE CABLE SYSTEM will be adopted for the Broadway surface road in this city as soon as the plant can be put in. Negotiations have been in progress during the past week, between the city officials and the company's officers. The company agrees to put in a cable system "less noisy than the one in use on 125th St." to run 24 ft. cars and light them by gas or electricity, and to keep them running all night at intervals of not more than 20 minutes. The paving between the tracks and for 2 ft. on each side is to be kept in repair by the company. The company paid into the city treasury last year $40,000 rent for the use of the Broadway system, 3 per cent. on the gross receipts, amounting to $32,231.55 tax on real estate, $11,655; personal tax, $90,163.55; track tax, $1,074.90; car license, $8,000, a total of $123,750, to which must be added $14,000 the company paid for street cleaning, making a total of $137,750.31. Since June 14, 1886, when the present company took charge of the lines, it has paid into the city treasury $707,654.37. Next June the city will be receiving 5 per cent. instead of 3 per cent. of the gross receipts.

It is thought that the introduction of the cable system will at least double the gross receipts, which will bring the company's annual tribute to the city treasury to about $235,000. The company guarantees that so long as it is not subjected to competition, its annual payments to the city, exclusive of minor taxes, shall not fall below $150,000 per annum.

On Nov. 12 the Board of Aldermen empowered the company to make the desired change to the cable system on the above terms. The State Railroad Commission is the only body whose consent is now needed, and no obstacles to the enterprise are apprehended from that quarter.

DESIGNS FOR A 1200 FT. TOWER are wanted by the Tower Company (Limited) of London. Prizes are offered of $2,550 for the best design and $1,275 for the second best design. With the design must be an estimate showing the weight of material, the cost of the elevators, and the cost of the labor in construction. The competition is open to all, and it is to be hoped that some American architects and engineers will make an attempt to capture the prizes. A jury of seven, among whom are Sir FREDERICK BRAMWELL, and BENJAMIN BAKER of Forth Bridge fame, are to make the awards. All designs are to be in before the end of February next, unless more time is asked for by foreign competitors. Specifications and further information can be obtained from the Secretary of the Company, ALFRED D. GARSIDE, of St. Stephen's Chambers, Westminster.

A CHIMNEY 455 ft. high is being erected at the Royal Smelting Works at Halsbruecke, in Saxony, says an exchange. It rises from a base 40 ft. sq.

THE LOUISVILLE AND JEFFERSONVILLE BRIDGE is well under way. As before mentioned, the Phœnix Bridge Co. has the contract, and Scoysmith & Co. are building the substructure, which includes three pneumatic caissons. The depth to rock at the site of one pier is 80 ft. This bridge will surpass all previous records in length of truss spans as it will have one 210 ft. span, one 550, one 553 ft., one 550 ft., and two 341 ft. spans, all center to center of piers. The total length of the bridge, including iron viaduct approaches, will be 8,805 ft.

PORTLAND CEMENT FROM LIME MUD, or the lime waste of alkali works, is the object of a newly started company in England, known as the British Patent Portland Cement Co. This company owns the patents of JOHN S. RIGBY for the making of "Portland cement" from caustic lime mud, sugar lime mud, etc. The process seems to be the treatment of the mud in such a manner as to extract the carbonate of lime, and to use this product, instead of chalk, to mix with clay in the manufacture of hydraulic cement. According to a test made by Mr. HENRY FAIJA, three parts of the lime mud to one part of clay, by weight dry, makes an excellent quality of Portland cement: after 28 days the test briquettes broke at 440 and 495 lbs. per sq. in.

THE BLACKWELL'S ISLAND BRIDGE CHARTER, we regret to learn, has been declared invalid by the General Term of the Supreme Court, and Dr. THOS. RAINEY'S long-continued labors on behalf of this project have for the present come to naught. Some features of the project have not seemed to us what they should be; but as a whole it is a needed improvement, which would greatly help to promote the growth of Long Island.

THE DETROIT UNION DEPOT ENTERPRISE is making excellent progress. At a hearing before the State Railroad Commission on Nov. 8, the proposed crossing of the company's tracks over the Michigan Central lines was approved. The crossing is to be by a viaduct, leaving 18 ft. headway between the Michigan Central tracks and the girders of the viaduct. The Detroit Common Council has voted to grant the company a franchise for an elevated structure on River St., with the right to cross Sixth, Fifth, and Fourth Streets. The depot company agrees to pay all damages arising from the changes in street grades, and is to pay into the city treasury annually 2½ per cent. of its gross earnings. Among those back of the enterprise are Hon. JAS. F. JOY and F. A. BAKER.

THE ST. CLAIR TUNNEL, under the Detroit River, is said to be progressing at the rate of 7 ft. per day at each end. About 200 ft. on the Canadian side, and 400 ft. on the American side, are reported as complete. The approach opening is about one mile long on each side and about 60 ft. deep. The shields are being used, in the hard blue clay, by digging out the center with picks, and then pushing them forward 18 ins. at a time by hydraulic rams. The freezing process is to be used if water is met with.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision on the Pennsylvania Railroad near Altoona, Pa., on Nov. 8. A train with an extra engine broke in two in the Gallitzin tunnel, and the engine and 38 cars ran away down the grade and collided with a work train, wrecking 5 cars and damaging the track. One man was killed and two were injured.——A freight train on the Spokane branch of the Oregon Railway & Navigation Co.'s road was derailed by a misplaced switch near Valley Grove, Wash., recently. The train ran on the ties till it reached the bridge. "Here the engineer, seeing the imminent danger, pulled the throttle wide open and crossed in safety, although every wheel in the train was off the rails." Four cars went over the bridge.——Two other misplaced switch accidents are reported: on the Jersey Central Railroad near Roselle, N. J., Nov. 9., a coal train being turned into some empty cars on a side track; and on the Central New England & Western Railroad, near Campbell Hill, N. Y., Nov. 12, a passenger train being turned into a side track to the car shed.

A SERIOUS ACCIDENT, caused by train wreckers, occurred on the Lake Erie & Western Railroad, near Kokomo, Ind., recently. A disused switch had been spiked to prevent accidents, but the wreckers pulled the spikes and forced the switch open. The engine and 19 cars were wrecked; 13 oil cars were in the wreck and caught fire, destroying the whole train except five box cars and the caboose. About 100,000 galls. of oil were burned, and set fire to some buildings; the stream of oil also flowed down to a small creek and set fire to some bridges. Three men were killed.

BRIDGE ACCIDENTS are reported as follows:——The bridge over the Conemaugh River between Cambria and Millvale, Pa., has been destroyed by the high water and drift in the river. It was a hastily constructed, temporary affair, built after the Johnstown flood.——The Benning's Bridge at Washington D. C., has been badly damaged by the freshet, and it is probable that a new structure will have to be built.——Several bridges in Washington County, Fla., have been carried away by floods.

A CABLE RAILWAY ACCIDENT occurred at Kansas City, Mo., Nov. 9. The brakes on a Fifth St. train failed as the train was descending a hill, and the train ran away, colliding with another train at the foot of the grade. One man was seriously injured.

A BREAK IN THE ERIE CANAL was caused at West Troy, N. Y., Nov. 8, by a canal boat striking the gates of the lock. The gates gave way, and the backed-up water in the level, 20 ft. above the river, rushed down through the lock, so that the basin was drained for its entire length of 6 miles. The damage to the canal amounts to between twenty and thirty thousand dollars.

THE PENNSYLVANIA RAILROAD'S DEPARTMENT OF MOTIVE POWER is to be congratulated on the successful manner in which it has conducted the delegates to the Pan-American Congress on their 6,000 mile trip through the United States. The running of a single train without change of engines for so long a distance and at such a rapid rate has never before been accomplished. The Pullman cars for the tourists were heated by steam and lit by electricity; and since on many of the roads to be traversed, no locomotives equipped with apparatus for furnishing steam could be had, it seemed best to attempt the feat of making the whole trip with a single locomo

tive. The engines elected was No. 1,053, Class O, weighing 91,000 lbs., built at the Altoona shops of the Pennsylvania Railroad. The greatest difficulties anticipated were the trouble in securing the proper coal for the locomotive on some of the lines, and the long continuous runs which would be required of the engine. All obstacles were successfully met, however, and the single locomotive carried its train over the whole journey of 5,825 miles without accident or delay. Even on long continuous runs of 300 miles, good schedule time was made; and on the trip from Omaha to St. Louis 476 miles were covered in 18 hours.

THE FAST WEST-BOUND MAIL SCHEDULE, says J. LOWRIE BELL, general superintendent of railway mail service, is to be reduced next week from 5 days, 8 hours and 15 minutes, to 4 days, 22 hours and 45 minutes, between New York and San Francisco. This is a saving of 9½ hours in transcontinental time.

EXTENSIVE MACHINE SHOPS, said to be the largest west of the Mississippi, have been built by the Mexican National Ry. Co. at Laredo, Tex. The buildings are of brick, with 18-in. walls, and iron truss roofs covered with corrugated iron. Round house, 65 x 100 ft., 18 ft. high, 20 stalls; foundry, 60 x 75 ft.; erecting shop, 60 x 119 ft.; blacksmith shop 59 x 60 ft.; two engine houses, 59 x 60 ft. and 30 x 31 ft.; wood working shop, 60 x 250 ft.; machine shop, 60 x 180 ft.; paint shop, two stories, 70 x 105 and 60 x 70 ft.; engine house, 30 x 35 ft.; boiler house, 40 x 40 ft. Also brick buildings for store rooms, offices, etc., and a bonded warehouse 30 x 250 ft. with a 20-in. wall and a tin roof.

THE THOMPSON ELECTRIC WELDING PROCESS is proving a very profitable invention. We understand that the British patents owned by the company have just been disposed of for $1,200,000. Negotiations are in progress for the disposal of the patents for various other European countries.

INCANDESCENT LAMPS ON BUOYS are a practical success after one year's test in the Gedney's channel entrance to New York harbor. During the last nine months over 220 ocean steamers passed through the channel during the night, and not more than two lamps out of six were extinguished at any one time. Red glass globes did not last as long as plain ones, probably owing to the interception of a greater portion of heat. Red lanterns are now used around clear glass lamps on all buoys.

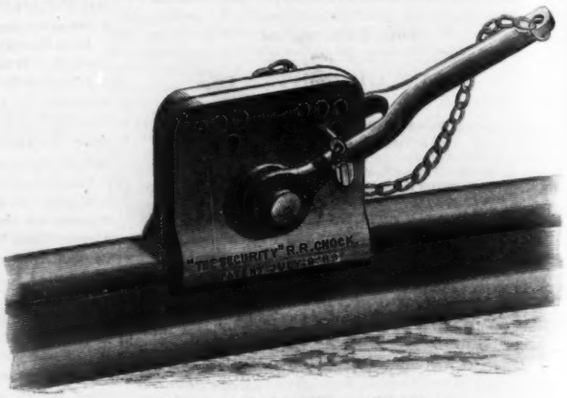
ANOTHER LOCAL ENGINEERING SOCIETY, the "Engineering Association of the Southwest," has been formed at Nashville, Tenn., as more fully noted elsewhere. It is significant that every one of its six leading organizers is also a Member of the American Society of Civil Engineers. The Constitution provides for three Directors from Tennessee, and for one each from each other State in which there may be ten members, to be chosen by those members. Duplicate nominations are required for every office and cumulative voting is allowed, each Tennessee voter being allowed to cast his three votes for director for one, two, or three candidates, as preferred.

THE FRUIT HILL RESERVOIR, of the Providence Water Supply, is completed and has been officially declared open to use in the presence of the Mayor, City Engineer GRAY, Mr. E. B. WESTON, the engineer in charge of construction, and a number of city officials. This is the high-service reservoir of Providence, R. I., the full-water level being 274.75 ft. above mean high tide. The Hope basin is 150.5 ft. and the Sockanosset basin is 180.5 ft. above tide.

THE STATE GEOLOGICAL BOARD OF NEW JERSEY, at its late meeting in Trenton, decided not to elect a State Geologist to succeed the late Prof. COOK, for the present at least. Prof. COOK left his work in such shape that the working force can go ahead with such assistance as Prof. SMOCK, associated with Prof. COOK from the beginning, can and will give. The main end in view, in this decision, seemed to be to save the salary of a State Geologist, —a doubtful economy, and one seemingly unfair to Prof. SMOCK, who is supposed to perform the duties of this official.

The Security Railway Chock.

The compact little tool which we illustrate, weighing only 20 lbs. and extending only 5½ ins. above the rail, is already in use on a dozen or twenty prominent roads, we are told, although but a few months on the market, and strikes us as a neat and meritorious device. Its *modus operandi* is so simple as to need no explanation beyond the cut itself, and its purpose is to give a ready means of chocking the wheels of a car or a train either in an emergency on the road or about a yard or station. How much need there is of having some such device always handy and in constant use, the accident record of every week bears witness. It is made of steel throughout, and is said to be capable of standing a strain of 50,000 lbs. It can be applied and removed in two or three seconds, and is so small and convenient, and withal so perfectly secure, that the field for its advantageous use would seem to be a wide one. It is manufactured by WM. G. ROBINSON, 66 Broadway, New York.



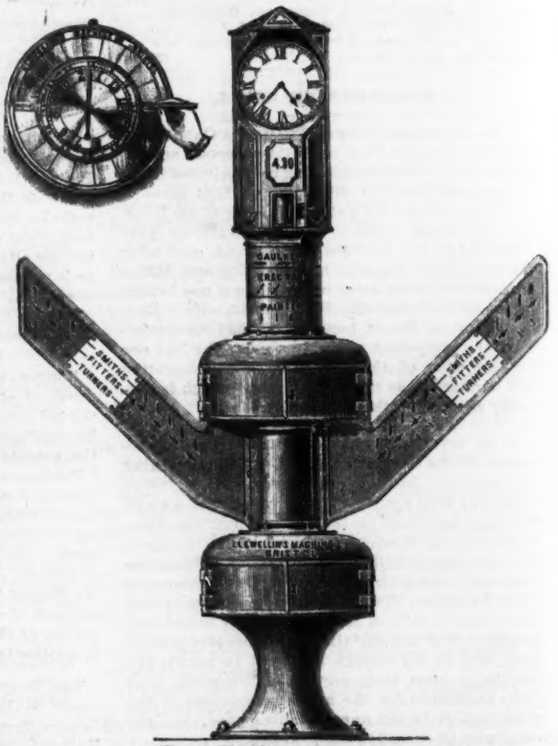
The Security Railway Chock.

The Llewellyn Time Checking Machines.

In all large manufacturing establishments the exact time of arrival and departure of each employé is an important feature in the adjustment of accounts, and the common forms of time-checking are troublesome, expensive, and not always accurate. The machine here illustrated has been in use in England for about six years, and is intended to obviate the difficulties referred to.

It is practically an eight-day clock combined with an ingenious checking apparatus, so arranged that each employé, by dropping a numbered metal check in a slot, keeps his own exact time of arriving at and departing from the works. The method of operation is simple. As an example, if 100 men are employed in a certain shop, each man receives his special number, and in the morning a check-board with 100 brass checks is hung alongside the machine. Each man as he comes in takes his proper check and drops it in a slot, and from 5 to 20 men can be doing this at one time. At noon a board with zinc checks is exposed for the men leaving, and copper checks fix the time of their return; the zinc checks will again fix the time of departure in the evening. Machines are made registering 12 checkings per day.

Another type, suitable for banks and offices, moves a paper roll by clock-work, and the position of the signature on the roll fixes the time of arrival or departure. Still another form of apparatus keeps the checks for the various trades in one shop separate and distinct. It is this particular one that is illustrated. The smaller cut shows an autographic checking machine admirably adapted to recording the visits of a night watchmen or for use in a small shop or office. Experience with these machines, of the various types manufactured, has shown that they save time and money, prevent favoritism or collusion, and avoid disputes as to actual time. It is impartial and fair to all, and has proved a favorite with the workmen where used. It is a machine that should be quite as useful in American shops as it certainly is in England. The American agents are E. P. Spalding & Co., 17 and 19 William St., New York, to whom parties interested should apply for further information.



Time Checking Apparatus.

Granite Paving Blocks.

City Engineer SCOWDEN, of Louisville, Ky., was lately sent by the city authorities to the Little Rock, Ark., granite quarries, from which the blocks are obtained that are now being used in paving the city streets. He reports that the quarries examined belong to Messrs. Ward & Newman, and are near the city of Little Rock, Ark. The stone is being quarried by steam drills, with a generally first-class plant. The average force employed daily, in making blocks, is 78 men.

The block makers make about 125 blocks each per day, and the price paid is 3 cts. each: 78 block makers will turn out in ten working hours 9,740 blocks, or six carloads of about 1,600 blocks each. Of the 40,000 blocks on hand, about 68 per cent. would pass close inspection. The total working force on the pay-roll was 283 men; divided into 115 block makers, 9 derrickmen, 73 laborers, 16 blacksmiths and helpers, 4 teamsters, 47 hand-drillers, 6 steam drillers, 6 miners, and 7 foremen. The average weight of each block is 34 lbs., or 65 blocks per ton. By their contract with the city of Louisville, the quarrymen must deliver 2,500 tons per month for 12 months, which they are equipped for doing.

The Soldiers and Sailors' Memorial Arch in Brooklyn, N. Y.

The Memorial Arch to the soldiers and sailors of Brooklyn, the cornerstone for which was laid on Oct. 16, was first started by the survivors of the war, who stirred up public sentiment until finally, in April, 1887, legislative aid was sought. By act of May 16, 1887, it was ordered that the Mayor and Common Council of Brooklyn provide for the erection of a soldiers and sailors' monument at an expense not exceeding $100,000; and in 1888 this law was amended so as to create the Mayor, the chairman of the Memorial Committee, G. A. R. of Brooklyn, and the President of the Board of Aldermen a commission to erect the monument. In 1889 the Laws of 1887 were again amended by authorizing a further issue of bonds for this purpose to the extent of $150,000, making a total of $250,000 available.

Proposals were issued for a design for the arch and thirty-six plans were submitted. The arch now under construction is being erected from drawings and models prepared by Mr. JOHN H. DUNCAN, architect, and it is under his supervision and that of Mr. ROBERT VAN BUREN, Chief Engineer of the city of Brooklyn.

The arch is descibed as follows in the Brooklyn *Times*:

Its total width is 80 ft.; its total height 71 ft.; its total depth 45 ft.; the height of the arch is 48 ft. 6 ins. and the width of the arch is 37 ft. The monument will stand on a course of polished Quincy granite 3 ft. high which acts as a surbase, lifting the monument above the street line and keeping the cut surface clean. A block of this course coming under the angle of the arch forms the cornerstone. The monument proper rests on this foundation forming an arch with the sizes given above. The material of the structural portion has not been decided upon as yet, but presumably will be of a light colored granite, and one that is easily cut, as it must be enduring, and the delicate details require a stone easily worked and one of a light tone to show a shadow. There are two pedestals facing the Park and two on the other face of arch towards the fountain. These are intended to receive bronze groups. The ends of the arch abutments are recessedfor bas-relievos. Directly opposite these on the inside, under the arch, will be equestrian figures in nearly full relief. All of the above figures will be in bronze.

The under side of arch will be finished with coffered panels. The keystones will be covered with the seal of the United States. In the two spandreis over the arch on fountain side will be the seals of the city and State. On the two spandreis on the opposite face will be female figures of victory carved in the stone. Discs encircled with wreaths are used in the panels of the attic story. These are to receive the names of the battles of the Rebellion in which Kings County regiments participated. The parapet line is to be formed with eagles resting on globes, with ornaments between. In each of the abutments flanking the arch there will be a flight of stairs, one for ascending and one for descent. These will extend to the top of the monument, from which point an extensive view will be had. Directly over the arch there will be a gallery, which can be used for a relic room for banners and other objects of interest that may be desired.

Soldiers and Sailors' Monument, Brooklyn.
JOHN H. DUNCAN, Architect. ROBERT VAN BUREN, Engineer-in-Charge.

The engraving here reproduced is taken from the architect's plan as distributed on the day the cornerstone was laid. The figures and groups in this sketch are about one-fifth too small for the actual dimensions of the arch, making the arch appear higher than it really is.

The Design and Construction of Railway Shops.

(*Concluded from p. 450.*)

GENERAL DISPOSITION OF SHOPS.

What may be called the typical grouping of American railway shops is to place them parallel with each other, and with their longitudinal axis at right angles to the main track (or chief yard siding), with several traverser beds and tables between them. In other words, the shops lie side by side with their gable ends facing the track.

The stalls (or shop tracks) being at right angles to the length of the buildings, or parallel with the main track, if the traversers are set in line with each other, a passage through from shop to shop is provided; that is, it makes a through temporary passage parallel with main track.

Good examples of this arrangement are the St. Paul workshops of the Chicago, St. Paul & Kansas City, and the West Chicago workshops of the Chicago & Northwestern (see engraving), and it has advantages, one of the chief being that if sufficient width of land is secured, it permits extensions in length to be built uniform with the existing buildings, without interfering with the ordinary railway work; and when the addition is completed, does not necessarily require a resetting of the machines, shafting or warming pipes, etc., in order to fully utilize the added space.

Until the use of electrically moved overhead cranes changes the shape and size of such shops, does away with the traverser, and alters their relationship to the main track, this grouping will probably continue to be adopted. It necessitates the purchase of a block of land, wide but not long.

One of its most prominent defects is the necessity for skylights. The side walls are so cut up by large stall entrance doors, almost filling the wall panel, that there is little space for side windows except those of limited size, framed into the leaves of the doors; while, as the door openings cannot be kept quite close and tight, in latitudes where cold high winds prevail, these numerous inlets interfere with the comfort and efficiency of the workmen. However, for a correspondingly brief period in mid summer, the doors thrown wide open are an appreciated luxury, compensating in some measure for the winter inconvenience.

So grouped, the buildings are well isolated in case of fire, as not only does the width of the traverser pit intervene, but in addition, there is a space of from 10 to 15 ft. between wall and edge of bed, ordinarily utilized in the storage of wheels and trucks.

A neat and compact arrangement was adopted for the shops built in the summer of 1887 for the Maine Central Railroad at Waterville, Me. The buildings are set on each side of a single traverser bed, and occupy but little land. The arrangement will not prove elastic should extensions become necessary.

In new works, buildings are rarely set closer than 50 ft. apart; 40 ft. will usually fulfil the requirements of the fire insurance inspection, while a distance of 35 ft. has been proved to be far too close for efficient side light even with one-storied buildings.

The new shops of the Panhandle Railway are set wide apart, with many large trees left standing in between them, forming a pleasing feature to the eye; but even in this country of cheap land, few railways subordinate considerations of economy to the gratification of an æsthetic taste, making the workshops ornaments in a natural park.

In vivid contrast to buildings spaced in this liberal manner are the works of the London & Southwestern Railway at Nine Elms, London, where the space under the viaduct carrying the four-track main line has to be utilized for shop room.

Freedom from snow, giving a wide liberty in roof design, simplifies the grouping of shops in Europe; and in Germany a style of shop not uncommon is one having a continued hip and furrow roof covering about 17 bays. With sufficient glass (part of it movable) there is no reasonable limit to the amount of light and fresh air admitted, and when artificial heat is necessary, the lack of height in the building is a help to the warming. In many instances the establishment is under one roof, as at St. Rollox on the Caledonian Railway, Scotland, the area being 12 acres; or the locomotive shops are under the one roof and the car shops under another The number of trolly tracks and power cranes, and the compact setting, makes the handling of material and work a simple matter.

In plan, the tendency is for the longitudinal axis of the main building, and the stall tracks, to run parallel with the main track, so that the plot of land required is long and narrow, as for instance in the Horwich new shops for the Lancashire & Yorkshire Railway, the erecting shop of 200 engines capacity, with 6 parallel tracks and a central machine bay, is 1,520 ft. long—almost ⅓ of a mile:

Although in Canada and the Northern States, shop roofs cannot be a continuous duplication of small pieces, yet the main buildings may have duplicate roofs, that is, a uniform span may be adopted for erecting machine, boiler, car and paint shops, etc. The Pennsylvania Railway has so designed and built combined shops that the portion originally used as car shops can at slight expense be adapted for locomotive repairs, when the growth in business shall justify the increase of this section and the removal of the car department to another location.

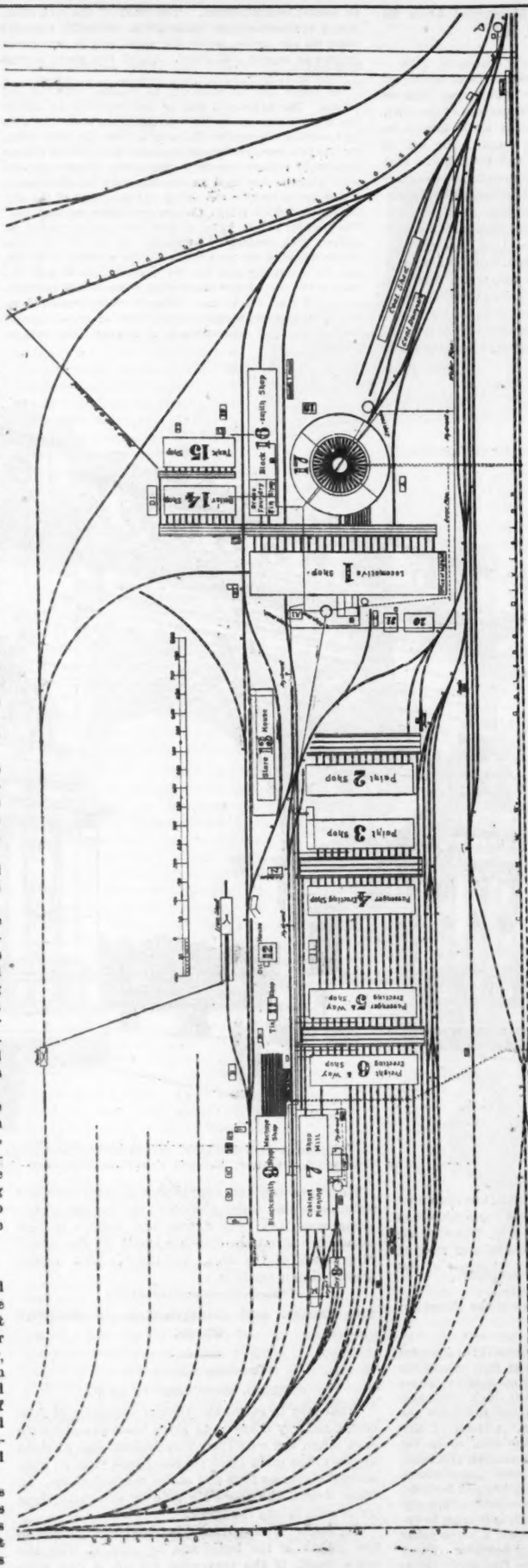
On the general question of grouping, the late A. L. HOLLEY may be quoted. Speaking more particularly of steel works, he remarks. "Joliet is perhaps the only establishment where railroads were laid out first and buildings made to fit; and in designing works, provision only can be made for minimum amount of rehandling and hard labor, by going over all the operations on paper by different arrangements again and again, and not trusting to general ideas to be worked out when it is too late to move a building that happens to be in the way."

For intercommunication, not only between the chief offices and foremen's offices, but also between shop and shop, and each bench and the tool room, electric bells, telephone service, and displayed signals, to call persons moving about through the works to the nearest telephone, are daily receiving more general adoption, and their usefulness is so marked that a single experiment with them is sure to result in their permanent use.

DISCUSSION.

Mr. F. BROWN, of the Canadian Pacific, questioned Mr. BARNETT'S statement as to the length of time required for engine repairs. Mr. BROWN said that in a divisional repair shop the limit of time for heavy repairs should be 60 days. This, however, does not mean rebuilding an engine. A medium repair should not take more than 30 days, and light repairs 7 to 14 days. In the *main* shop of a railroad company this time should be reduced to 42 days for heavy repairs and 21 days for medium repairs, as a maximum, while light and specific repairs might occupy 3 to 14 days.

In June, 1886, the Canadian Pacific Railroad shops at Montreal were ordered to build some new class consolidation engines. Complete working drawings had to be made and some material imported; but the first engine was on the road in just 90 days



after the receipt of the order. A year later, on an order for some 17 in. x 24 in. engines, the first engine made her trial trip 77 days after the receipt of the order.

Mr. WALLIS, of the Grand Trunk, endorsed the author's remarks commending the longitudinal type of engine shed. The Grand Trunk longitudinal shed at Montreal contains five tracks, and has a capacity of 25 engines. With the iron turntable outside, water service and steam heating pipes and appliances, sand house, and tool store, it cost about $50,000, or $2,000 per engine accommodated.

Another advantage of the longitudinal type of shed was the rapidity with which engines could be moved out in case of fire. The fact that all entrance to and exit from the round type of house depended on one turntable was not infrequently the cause of much annoying delay. Again, in severe weather, such a house as the one at Montreal could hold one extra engine on each track, by crowding the others very closely. In a roundhouse such extra capacity could not be obtained. He thought it likely that the first cost of the round type of house per engine accommodated was rather less than that of the longitudinal type, and that in laying out yards it was generally more convenient to spare the block of land required for a roundhouse than the long, narrow strip required for a longitudinal shed. Skylights in an engine house were never satisfactory; they subjected the roof to unnecessary chances of decay and were difficult to keep clean. The light from side windows was much more evenly distributed in the round type of house.

Mr. J. HARKOM endorsed the suggestion of the author that repair shops should generally be arranged on the rectangular system. The sorting of cars had to be done in any event, and the work should be so systematized that whole trains of completed cars would be turned out together. More cars could be worked upon in a longitudinal shop than in a shop of the same area of the other type. Shops should be so arranged that the tracks to them will be always open, and cars can be readily delivered from the works to the main line.

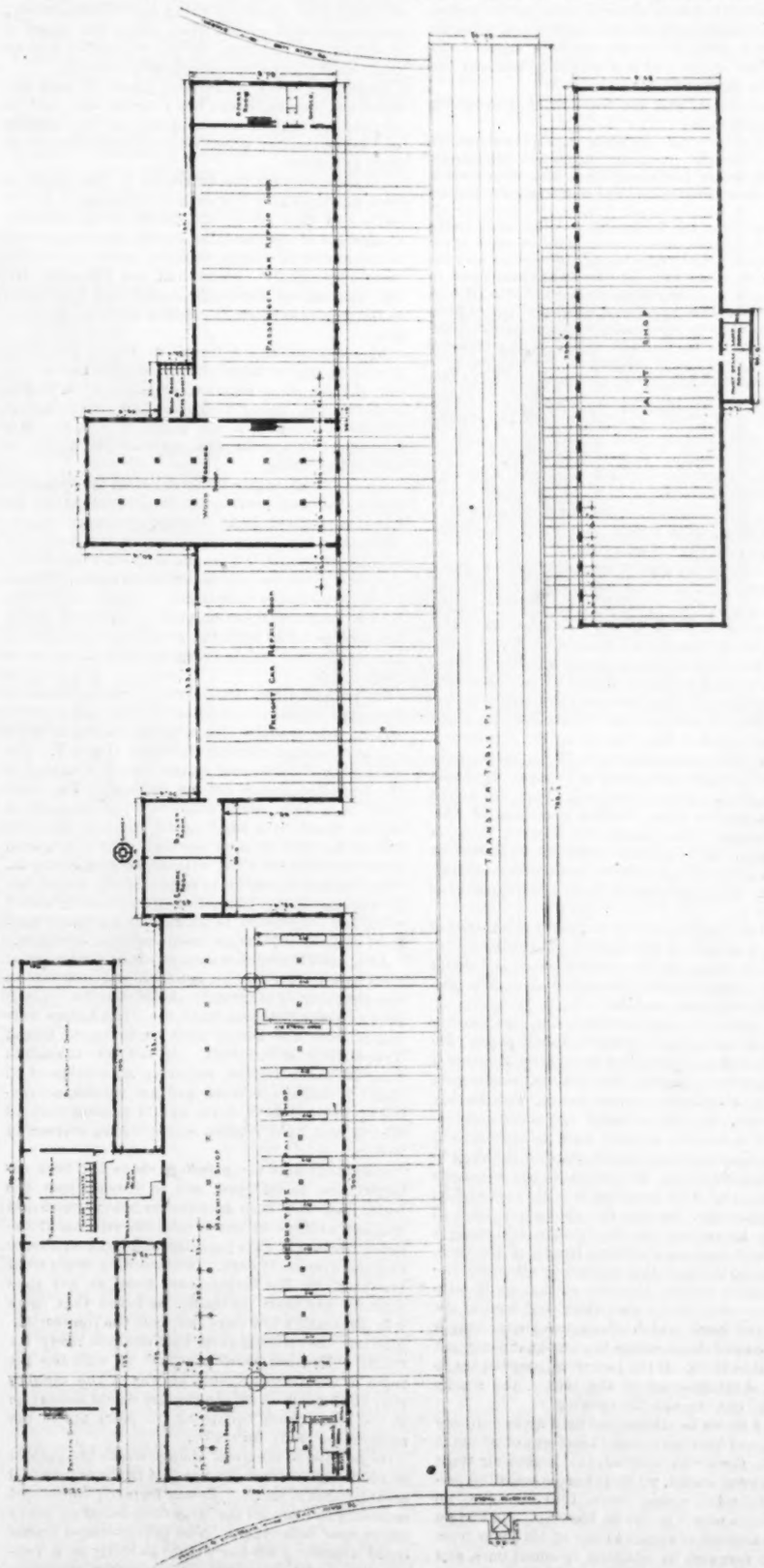
In regard to stores Mr. HARKOM made the following suggestion:

> The fact that in large works every time a piece of work is handled it costs more or less money, should never be lost sight of; and that system is the best which provides for the fewest handlings outside those absolutely necessary for manufacture and treatment in the different processes.
>
> All material should be delivered at the stores, weighed, measured, and tested by officials of that department. The stores should be located in such a position that easy access can be had to them by trucks and wagons.
>
> The object of the works being to turn out finished articles in the shape of engines and cars, the stores should be placed between the two sets of shops, with the idea that raw material supplied from them should issue in the shape of finished work at the opposite end of each set of shops.
>
> The shops handling the heaviest material should be nearest the stores; therefore the first shops in the locomotive series should be the boiler shop, then the smith's shop, the machine shop, wheel shop, erecting shop, tin shop, and paint shop in the order in which they are named.
>
> Lumber being a special article of large bulk, and necessitating a large stock, should be kept in its own yard a considerable distance from the works; but access to it should be readily had from the main tracks. The position of the foundry is much the same as that of the stores; and it should be located as near to both locomotive and car shops as possible.
>
> Two tracks should run the whole length of the works with frequent cross-over switches and connection to the transfer table in boiler and erecting shops, if such is used; and by the simple precaution, in first laying out the shops, of establishing the floor levels two feet above the mean out-door level, which will ensure dry ground around the shops, the traversers may be worked out of doors, even in Canada, so saving the extra roof referred to by the author.
>
> Where the traversers can thus be used, it is, in the opinion of the writer, far preferable to the overhead system, which calls for construction of the shops in a much more expensive manner than the traverser system.

Mr. HARKOM favored the distribution of power from a central boiler house by steam pipes rather than from large engines by ropes, belting, shafting, etc. The shops for the manufacture of permanent way material should be set somewhat by themselves. The locomotive yard should be on the same side as the erecting shops, to which two tracks should lead, one for the delivery of new boilers and engines under repair, and the other for the exit of the completed engines *en route* to the paint shop.

Regarding roofs for engine-houses, he commended a double roof as preventing condensation and the formation of icicles in cold weather, and described as follows a roof erected by him in 1888:

The old roof was a flat one, a little over half an acre in extent, covered with the ordinary gravel and tar felt. The gravel was all scraped off the felt, which was patched and repaired with Sparham roofing material, where such was necessary, after which 4-in. scantlings were laid, and common boards laid on them, the ends being partially closed by overlapping at eaves, in order not to entirely prevent circulation. The building was then handed over to the roofers, who readily gave a ten years' guarantee for the roof, the contractor telling the writer that his experience of double roofs was that he had no repairs to do to them, the action of the weather, snow,



Plan of Maine Central Railroad Shops at Waterville, Me.

ice, etc., being practically reduced to the very lowest possible point.

For slate on pitch roofs, excellent results have been obtained by laying the slates on strips pitched the right distance apart, three winters at Athabaska having failed to show an icicle on the eaves, and others since built give the same result. Slate on a roof with pitch of 1 to 3½ had been successfully laid on fuel sheds, and this winter he has seen the snow slide off that roof.

On the material and construction of ventilators, Mr. HARKOM said:

The use of iron has the effect in cold weather of creating a conflict of currents in all iron ventilators, which the writer has found is not done when wood is used, the sides being doubled and an air space left around them.

The painting of the inside with fireproof paint makes them perfectly safe, while a down draught never takes place in them. The writer has in cold weather seen vapor descend on an iron ventilator, and directly pass to and out of a ventilator made as described of wood. A number of these are in use on engine sheds, placed there under the writer's supervision, with good results; and they are in use on the roofs of the smith's shop and foundry of the Grand Trunk Railway at Montreal.

Mr. ATKINSON referred to the subject of foundations, and thought that iron pillars run down below the floor level would be liable to rust and become weakened in made ground.

Some track pits he had seen were of very bad construction. They were often made with a concave floor, so that the workmen stood in water unless there was a good system of drainage. He advocated a convex floor, with a brick setdown at each side about 4 ins. deep to act as a gutter.

When the round type of engine house was used, he favored a roof with outward slope rather than inward, as proposed by the author. The system of roof covering adopted by Mr. HARKOM would give great freedom from the nuisance of icicles.

As to the use of cranes, he was heartily in favor of the overhead traveling crane. They were such labor-saving appliances that a break-down with one was as bad as having 20 or 30 men away from the shop. The cranes of this type, under Mr. ATKINSON'S charge at the Canadian Pacific R. R. shops, have a span of 55 ft. and a capacity of 25 tons. They cost about $3,000 f. o. b. at Liverpool. They are driven by 1¼ in. manila rope, running at a speed of 2,500 ft. per minute. The makers were Craven Bros., of Manchester. A single-rail crane of Ramsbottom make, in use by Mr. ATKINSON, gives also much satisfaction. It has a radius of 13 ft. and a capacity of 3 tons.

As to the foundry, he did not favor the L type of building proposed by the author, since it would interfere with the use of an overhead crane, and would also give a large expense for wall and roof in proportion to the space occupied.

In the smith's shops, no doubt, many were using the central smoke flue referred to in the paper. He had got rid of a smoky shop by making the roof a better type of ventilator. The ordinary single-span roof with a clere-story open below, and having louvre sides, was not adapted for getting rid of smoke. The louvres allowed snow to blow in, and the air could not get out freely, causing the shop to become full of smoke. He roofed up the principals of the main roof with boarding to within about 2 ft. of the ridge-pole, leaving the clere-story open at each side by taking out the louvres, and made a ventilator of it along the whole length of the shop.

He came to think of this method by observing the new Canadian Pacific Railway station on Dominion Square, which had a clere-story roof open at the bottom, and with which there was invariably a great deposit of snow, while the smoke did not get out as it should do. If the roof were boarded up to within a short distance of the center, the smoke would pass out through the opening.

The roof which he altered was held up by ordinary supports, and boarded across in sections of about 15 ft. When there was no wind, the heated air went out of its own accord, while the cross boarding prevented the wind going down into the shop, no matter which way it might be blowing. He had an excessive amount of smoke in one of his shops from two large furnaces in addition to small ones, and the first result of his arrangement was the removal of the sulphur, which had given them much trouble, the smoke following it away. He had not attempted to reduce the amount of suction, simply leaving it open. The clere-story was left exactly as before, and he boarded up within about 2 ft. from the center of the ridge-pole.

While speaking upon this subject, he said he intended to try his system of ventilation in a shop which it was necessary to keep warm at night, and in doing so he would put rising and lowering doors, one on each side, so that when either was raised it would act as a deflector. In this way he felt sure he could clear a smoky shop in twenty minutes.

Regarding floors, he favored plank for both machine and erecting shop; but if earth was used he advised covering it with a mixture of iron borings and sal-ammoniac, which would in time become as hard as asphalt.

He accounted for the difference in the length of time mentioned by the author as necessary for repairs and that set by Mr. BROWN by the excellent equipment of the Canadian Pacific shops, especially in the matter of cranes, enabling them to turn out work very rapidly. About half the Canadian Pacific locomotives were built abroad, and these came in for repairs as often as engines built by the company.

Mr. MACPHERSON referred to the trouble with icicles on engine house roofs, and said he had got rid of them at a nominal expense in an engine house erected under his supervision at Hochelaga in 1886 by building a few pieces of 2-in. diameter iron pipe into and through the walls just under the roof at the gables.

Several brick engine houses built on the Canadian Pacific Railway, previous to this, without these air holes, have given great trouble, on account of the icicles backing the water up under the eaves and ruining the walls. The one referred to at Hochelaga has given no trouble in this respect, and the icicle formation is very slight. At the same place may be seen a 65-ft. wrought-iron turntable, which length does away with the frogs leading to the engine stalls; the angle being 9° between centre of pits.

He preferred the radial type of engine house to the longitudinal at all points where time was an object, and thought that a turntable was a much quicker means of turning an engine than a Y. The sides of the double roof on the Montreal station of the Canadian Pacific are not finished. The clerestory is to have small windows all around, which will be closed by a small chain, running along the side of the roof, in snow storms. The slat system could not keep snow out without keeping smoke in.

Mr. BARNETT replied to several of the criticisms. He thought that if iron pillars were properly coated with tar, they could be carried down below floor level without any danger resulting from corrosion.

As to the difference of opinion about the length of time required for repairs, much seemed to be due to the difficulty of accurately classifying the various jobs as heavy, medium, light, etc. His figures were taken from the actual work done on the Grand Trunk shops at Stratford. In one year 76 engines received heavy repairs, requiring an average of 62 days; 21 engines received medium repairs, occupying an average of 29 days; and 37 engines received specific and light repairs, occupying an average of 20 days.

Since that date the Stratford shops had been enlarged and re-equipped, and in 6 weeks past the work done had been as follows: heavy repairs, 11 engines, average 92 days; medium repairs, 12 engines, average 32 days; specific and light repairs, 32 engines, average 23 days. In examining to see what per cent. of his locomotives were at any time actually available for traffic, he found that there was generally a few days lost from the time an engine left the erecting shop until she was ready for traffic. Engines sometimes had to wait for pit room or for painting, and he was of the opinion that 4 to 5 per cent. of the engines would neither be in the repair shop occupying pit room nor in the roundhouse ready for traffic.

He referred to the great change which the general introduction of cranes had caused in the economical arrangement of shops. It was formerly considered necessary to place all the large tools handling heavy pieces near each other. Now that overhead cranes could transfer a ten-ton weight as easily as a two-ton, the tendency was to group together machines of the same kind and thus make one attendant able to do the greatest possible amount of work. In the L shaped building, which he recommended for a foundry, a single jib crane could be made to cover nearly the whole area of both wings of the building If an overhead traveling crane was used, of course a square or rectangular building was the best type.

Mr. MACPHERSON'S simple plan for avoiding icicles on engine-house roofs, he considered most valuable. He supposed the current of warm air from the interior melted the icicles or prevented their formation.

He emphasized again the advantages of the rectangular type of locomotive shed. The English railway official before referred to, who handled 400 engines daily, claimed that with the rectangular shed he could turn his engines outside and get them in exactly the right position to take out their next trains shortly after their arrival and nine or ten hours before they were due outwards again; whereas with an annular engine house, he could not have got the engines turned and into position again at certain busy hours of the day without taking them out of the engine house and leaving them outside, which would require extra siding room where space was valuable.

An incident was related where a central turntable in an annular engine house broke down at 2 o'clock in the morning just before the engines inside were due to leave. The engines were shut up for about ten hours, throwing the traffic department in great disorder. Such serious mishaps were rare; but a district officer seldom got through a winter without some failure to a turntable. A turntable was necessary with the longitudinal type of shed, but its failure did not lock the engines in the shed.

Mr. HARKOM had referred to the ideal grouping of shops. The author had considered such a mode of discussing the question, but had finally decided that the paper would be of less interest and value than if it had dealt with the work done under the limitations of actual practice.

Proposed Street Numbering Plan for Chicago.

Chicago, in gathering into one metropolitan district a number of bordering and formerly independent towns, has struck the snag of duplicated street names and a woful mixing up of house numbers. The attempt is now being made to adjust these differences, so that in the future a carrier who has to deliver a letter addressed to A.B., No.—— Washington Street, Chicago, may not have to guess which particular one, out of four Washington Streets, now existing, is meant. The following is the outline of a plan as suggested by Mr. JOHN M. CLARK, of Chicago, and it is the plan practically agreed upon by the special Committee on Street Nomenclature of the Chicago Council:

That which is commonly known as the Philadelphia plan, giving 100 numbers to each block, wherever it can be made applicable, is undoubtedly the best system yet devised. It has been adopted in many of the large cities of the country and is now in use in Chicago to some extent. The system has generally been used where the cross streets were known by numbers, the especial advantage being that the number of the cross street used as a prefix becomes a part of the house number in the block adjoining, thus denoting the exact location. I would recommend the extension of this system to all the remaining parts of the city, using the section line streets as a skeleton of frame work.

Assuming that for the north and south streets a dividing or base line will be established somewhere near the river, from which line the numbering will begin for the streets running north as well as for the streets running south, the first section line street north of this base line would be Chicago Ave., the second North Ave., the third Fullerton Ave., fourth Belmont Ave., etc. Commencing with No. 1 at the base line, allot 1,000 numbers to each mile. From this base line up to Chicago Ave. the numbers would be under 1,000; from between Chicago and North Ave., between 1,000 and 2,000; between North and Fullerton Ave., between 2,000 and 3,000, and so on. Allowing as nearly as possible 100 numbers to a block, and putting all even numbers on the west side of the street, as is now done in the South Division, would give nearly a perfect system. In the number of any house each figure would have a meaning and would give precise information. For instance, take a number, say No. 3215 Wells St. The figure 3 would show that the house was three miles north of the base line, the figure 2 that it was two blocks north from the section line, and figures 1 and 5 would denote the position of the house in the block and that it was on the east side of the street.

For east and west streets I would adopt precisely the same plan, beginning at the most easterly point within the city limits, which would be near the harbor of South Chicago, numbering toward the west, allotting 1,000 num-

bers for each mile and commencing a new thousand at each section line. State St. being the fifth section line street, the numbers between State and Halstead Sts, would be between 5,000 and 6,000; between Halstead St. and Ashland Ave., between 6,000 and 7,000, etc.

With this system adopted throughout the whole city, the number of a house would give exact information as to its location. We should soon all come to know which are the section line streets and that a number on an east and west street, between 5,000 and 6,000 for example, must be between State and Halstead Sts., and that this would be equally true were the house in South Chicago or in Edgewater, or anywhere between those extremes.

The north and south streets in the South Division conform so nearly to the system here proposed that it would not be necessary to make any change in their present numberings; in fact, it would hardly be possible to do so while the streets are named by number as at present, and on the West Side, south of Twelfth St., probably the same system would have to be adopted.

There would be found some obstacles in working out the details of this plan, but I do not think they would be serious. For instance, in places there would be found more than ten blocks in a mile; but where this occurred the blocks would be necessarily short ones, and a hundred numbers would have to reach over two of them Five hundred will cover a mile of street, giving a number to each 20 ft, allowing 280 ft. street space unnumbered, so there will be plenty of margin. To those unfamiliar with this system, the use of the large numbers might at first seem an objection, but in practice this is not found to be the case. In speaking the number it is divided, as 5024, would be 'fifty twenty-four,' the first two figures giving the general location of the house and the last two its specific location in its own block.

The plan is similar to that discussed heretofore by the committee, except that it provides 1,000 numbers to the mile instead of 800. The committee decided to work under this plan, but stands ready to examine and adopt another if it has superior advantages.

A Combination Cross-Over or Slip Switch.

The neat and ingenious cross-over, which we illustrate in the accompanying engravings, was put on the market a short time ago by the Weir Frog Co., of Cincinnati, O., and seems to be meeting with much favor.

Our engravings, which are made from photographs of a switch now in use in the yards of the Central Union Passenger Station in Cincinnati, show the general arrangement of the switch rails and throwing mechanism very well. It will be seen that when the switch is in position shown in Fig. 1, a train running through from the right-hand track will be sent to the right-hand track, and a train coming on the left track will take the left track. When the switch is thrown to the reverse position, as shown in Fig. 2, trains running through will cross from left to right and right to left.

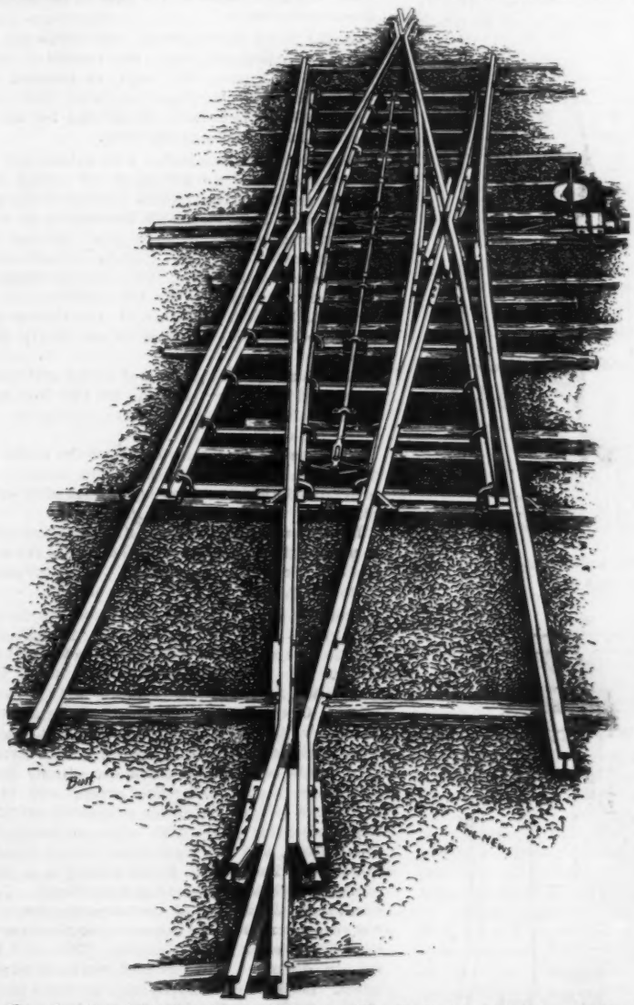


Fig. 1.—Combination Cross-Over or Slip Switch with Longitudinal Duplex Movement. Made by the Weir Frog Co., Cincinnati, O.

(Engraving made from photograph of a switch for yards of Central Union Passenger Station, Cincinnati. Switch thrown for trains from right-hand track to right-hand track, or from left track to left track.)

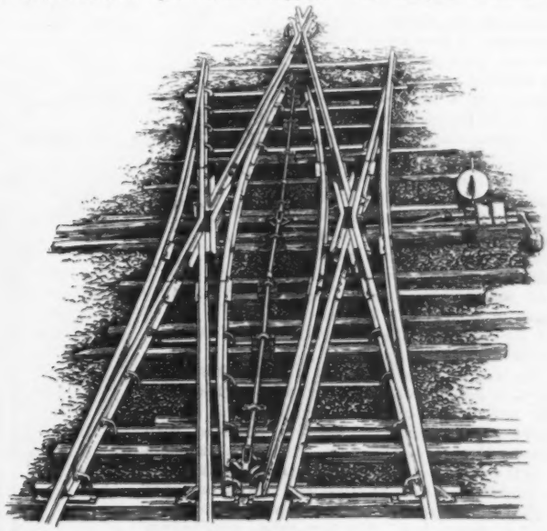


Fig. 2.—Combination Cross-Over or Slip Switch in Central Union Passenger Station Yards, Cincinnati, O.

(Switch thrown for trains to cross from left track to right track, or from right track to left.)

The mechanism for throwing the switch is shown very well in the engraving, except for the fact that the under longitudinal rod is hidden by the upper one. The working of the mechanism, however, may be easily understood. The stand is the Weir Company's automatic low target ground throw-stand. A rotary motion is given to the central shaft of this stand by throwing over the weighted lever. This central shaft has spiral grooves upon it, in which work the heads of the rods which actuate the toggle joint at the center of the switch. The spiral groove is practically a screw of steep pitch, and the rod-heads being free to move longitudinally, but not to rotate with the spiral, are pushed in or out in the same way that a nut is moved lengthwise by rotating the screw on which it is placed.

A very great advantage of this type of gear for moving switches is that by giving the spiral a varying pitch, steepest at the center and decreasing to nothing at the ends, any force applied to the switch rods when fully thrown in either position has no tendency whatever to rotate the shaft and turn the switch. It forms really an automatic lock, perfectly secure against all external forces applied to the switch rails or rods.

Following further the workings of the device, it will be seen, on reference to the two engravings, that the switch-stand exerts a push on one of the rods which run from it to the center of the tracks and a pull upon the other. One of these rods is connected to one side of the toggle joint at the center of the tracks and the other rod is joined to the other; hence the pull on one rod and the equal push on the other gives an equal pressure on each side of the joint. The long rod, extending along the center of the tracks and connected at both ends to the toggle-joints which move the split-rails has below it a similar rod connected to the other joint of these toggles. Now one joint of the toggle at the center, opposite the switch-stand, is connected to the upper one of these long rods and the other joint is connected to the lower rod. Thus as the center toggle is opened or closed by the switch-stand, a pull and a push is exerted each way from the center to open or close the toggles attached to the split rails.

It will thus be seen that the whole arrangement is extremely simple; and as the pull on one joint of each toggle is balanced by a push on the opposite joint, there is no side strain whatever on any part of the mechanism. Even at the switch-stand there is no side strain either way, and the safety of the switch does not depend at all on the strength of the fastening which holds the stand to the switch timber.

This type of switch also operates with but little friction, since each pull is balanced by an opposite push; also, since there are no side strains, there is no danger that the switch will become misplaced through the giving way of the fastenings.

The switch illustrated in our engravings is a No. 7 with the following dimensions; angle, 8° 10' length between extreme frog points, 66 ft. 10 ins; length between switch points, 44 ft., 2 ins.; radius of outer rail, at center of curve, about 438 ft.; diameter of center sliding rod which throws switch points, 1¼ ins.

All the rods are provided with turnbuckles, so that the switch can always be kept adjusted to hold the split rail firmly to the stock rail; and wear and lost motion can be taken up very readily at any time without causing delay to trains. The combination is manufactured by the company under seven patents Since this cross-over was first placed on the market, about six months ago, twenty-five have been completed and placed in use, of which, eight are in the Pittsburg, Cincinnati & St. Louis yards, in Cincinnati, eight were for the Chesapeake & Ohio, three were for the Cleveland, Chicago, Cincinnati & St. Louis, two were for the Cincinnati, New Orleans & Texas Pacific, two are in the Chicago yards of the Chicago

& Western Indiana R. R., one is in the Union Pacific yards at Omaha, and one was sold to the Decatur, Chesapeake & New Orleans Company.

A Contractor's Portable Light.

The illustration here given shows in more detail the Wells Light, described in this journal on Aug. 20, 1889. As there mentioned, the light is produced by the generation and burning of the vapor of kerosene oil, which is pumped into a steel tank by the small hand-pump *M*. The operation of pumping compresses the air already in the tank, and when the valve in the standpipe *A* is opened, the oil is forced to the burner by this pressure. A pressure of 20 lbs. per sq. in. will keep the light in working order for about 4 hours; and a fresh supply of air or oil can then be pumped in without stopping the lamp. The oil is conveyed to the tank through the flexible hose *K*, from a bucket or other receptacle. The burner is first heated by burning in it some cotton-waste, and after that it will in itself convert the oil into inflammable vapor. The flame is a powerful, horizontal jet of great brilliancy, equal to about 2,000 c. p. in the larger lamps.

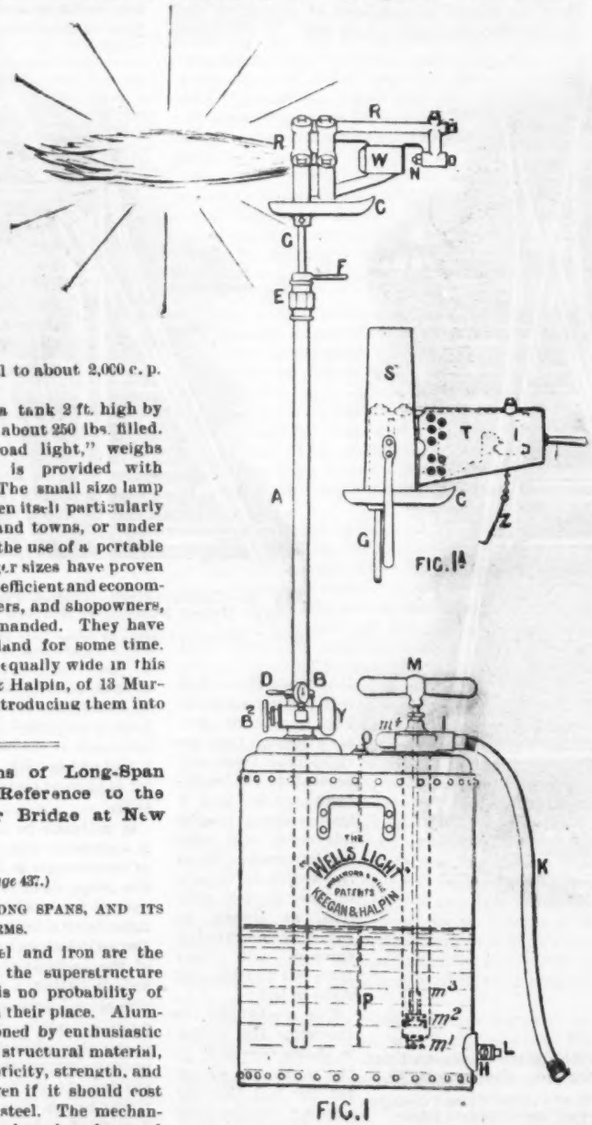


FIG. 1

The Wells Light; for Contractors' and City Use.

The largest size of light has a tank 2 ft. high by 18 in. in diameter, and weighs about 250 lbs. filled. The second size, or the "railroad light," weighs about 170 lbs. charged, and is provided with handles for ease in carrying. The small size lamp weighs only 70 lbs. and has proven itself particularly useful in street work in cities and towns, or under any circumstances demanding the use of a portable light of great power. The larger sizes have proven themselves a most excellent and efficient and economical light for contractors, builders, and shopowners, where an outside light is demanded. They have been extensively used in England for some time. The field for them seems to be equally wide in this country, and Messrs Keegan & Halpin, of 13 Murray St., New York, are now introducing them into this market.

The Economic Conditions of Long-Span Bridges with Special Reference to the Proposed North River Bridge at New York City.

(*Continued from page 437.*)

II.—SUITABLE MATERIAL FOR LONG SPANS, AND ITS ECONOMIC FORMS.

As already pointed out, steel and iron are the only materials practicable for the superstructure of long span bridges. There is no probability of anything else ever being used in their place. Aluminum, which is so often mentioned by enthusiastic progressionists as the coming structural material, on account of its lightness, elasticity, strength, and ductility, will never be used, even if it should cost no more pound for pound than steel. The mechanical value of the best aluminum bars is only equal to that of steel bars of 39 tons tensile strength per square inch. That is, taking a steel bar and an aluminum bar, about 23,000 ft. long, each would just support its own weight suspended. Aluminum has only about one-third the strength and about one-third the weight of such steel. Aluminum wire shows no increase of strength, while on the other hand that same steel, drawn into wire of No. 7 Birmingham gauge, would have a strength of about 85 tons. But steel wire of 150 tons strength per square inch can be obtained. Steel and steel wire will forever remain the strongest known materials for constructive purposes. Steel wire is pre eminently adapted for long-span bridges. Aluminum will be extensively used, but not for the building material of bridges.

The economical value of steel wire has been enhanced by a gradually lowered cost and an improved quality. For the Brooklyn Suspension Bridge, twelve years ago, the proper quality of wire could be obtained only from crucible steel, the most costly of all. At present, wire more uniform, and just as tough and strong, can be obtained from steel made by the open-hearth process at less than half the cost. The extraordinary toughness of this material is proven by the test of bending cold to a loop round its own diameter.

In very long spans, saving of dead weight is of the greatest importance. Steel wire admits of this being done in an unsurpassable degree.

For the above described system of suspended arch cables of steel wire, the length of span which could with safety be bridged grows to over a mile in length for supporting railroad trains. It is doubtful whether the necessity will ever arise for such a length of span.

The durability of steel wire is as great as that of other iron or steel members, and it is more durable than stone in our climate.

Thus in Roebling's railroad suspension bridge over the Niagara River, the wooden stiffening trusses were replaced with others of steel ten years ago; the stone towers were replaced with steel towers three years ago; but the original cables still exist and require no replacing, though, since the bridge has been built, train loads and locomotives have increased 60 per cent. in weight and the frequency of trains has increased over 300 per cent.

The iron wire cables of the old Smithfield Street bridge in Pittsburg, built by the late JOHN A. ROEBLING, in 1847 (and rebuilt by the author in 1882, with a steel truss bridge of larger spans), did not show the least sign of weakness after thirty-five years of very hard usage. The cables in this bridge were light—only 4 ins. in diameter—and from the heavy traffic over it were strained almost every day to nearly half their ultimate strength. The No. 8 wire (Birmingham gauge) was tested when the bridge was torn down. It showed no diminution of strength. The tests showed from 95 to 100,000 lbs. per sq. in., in spite of the hard usage of the bridge. The cables had never stretched from their original chamber. Almost every part of the bridge, from the foundation up, was worn out and decayed except the wire cables. They were made of parallel wires and wrapped with a softer annealed wire in the same manner as all later wire cable bridges, including the largest, the Brooklyn Suspension Bridge.

In the North River Bridge, the cables will also consist of parallel wires; but instead of being wrapped with wire, they will be enclosed in a water-tight steel envelope one-eighth inch thick, which will be removable in sections for the inspection and painting of the wires.

Between the consolidated wire cables, and that protecting shell, an air space of about 2 in. will be left to prevent uneven heating of the wires by the sun. Experience and observation on existing suspension bridges show that the sun does heat the cable unevenly. Certain internal strains are necessarily the result. They are not dangerous and are fully covered by the usual margin of strength, but it is desirable to avoid them altogether, which will be done in the North River Bridge.

The diameter of the finished cables will be 4 ft. There will be four such cables, each two, 50 ft. apart vertically, will be braced together to form the rigid arch ribs, above described.

The connection of these braces to the cables will differ from those in use, being much stronger and so arranged that the couplings cannot slide on the cables.

The towers will be of the open lattice construction to present the smallest possible surface to the wind, and also for economical reasons. Stone towers are more costly, particularly for great heights.

From the cable arches will be suspended the platform, built of steel, and arranged for accommodating ten tracks in two stories, six below and four above. The suspended steel girders, 40 ft. high, will be auxiliary to the arch ribs in their stiffening effect. Of themselves, they would not be sufficient to preserve the form of the cables, if that function were assigned to them. As already remarked, they would have to be made exceedingly heavy and much higher, and would greatly add to the cost of the bridge. A heavier suspended structure requires heavier towers, with larger and more costly foundations, and the anchorage masses must be increased. The weight of the cables, it is plain, affects the whole structure and its economy. To reduce, then, the weight of the suspended structure, the suspenders from the cables to the platform will likewise be made of wire cables. They will be 6 ins. in diameter, and made of wrapped parallel wires. Their weight will be only one-third of that of wrought iron suspenders of same strength.

Another reduction of weight is obtained by leaving off the usual heavy timber ties for supporting the rails. These will rest lengthwise on cushioned bearings directly on longitudinal steel box beams, so arranged that a train cannot possibly leave the track. A strong wire netting will take the place of the solid flooring. It is much lighter, does not retain water or snow, and opposes no surface to a wind, striking the bridge either from below or above. It will, besides, be strong enough to hold up a wrecked train.

Large as the anchorage masses need to be and as they appear, their cost is not correspondingly great. If the foundations were on ground which had to be artificially reinforced for resistance to pressure and sliding, the cost of the anchorage would indeed be formidable. But, as already remarked, the resistance will come from the unyielding rock itself, and the anchorage masses are merely needed to hold the anchors down in the rock by their weight. This weight need not be obtained by costly masonry, but simply by stone ballast encased in masonry. Its form is constructively and architecturally correct. The anchorage portals will really be partly

open tunnels, 300 ft long, forming a grand and fitting entrance to the colossal bridge.

The absence of similar portals in the great Brooklyn Suspension Bridge is universally recognized, but may some day be supplied.

IV.—PROVISION FOR TEMPERATURE EFFECTS AND WIND PRESSURE.

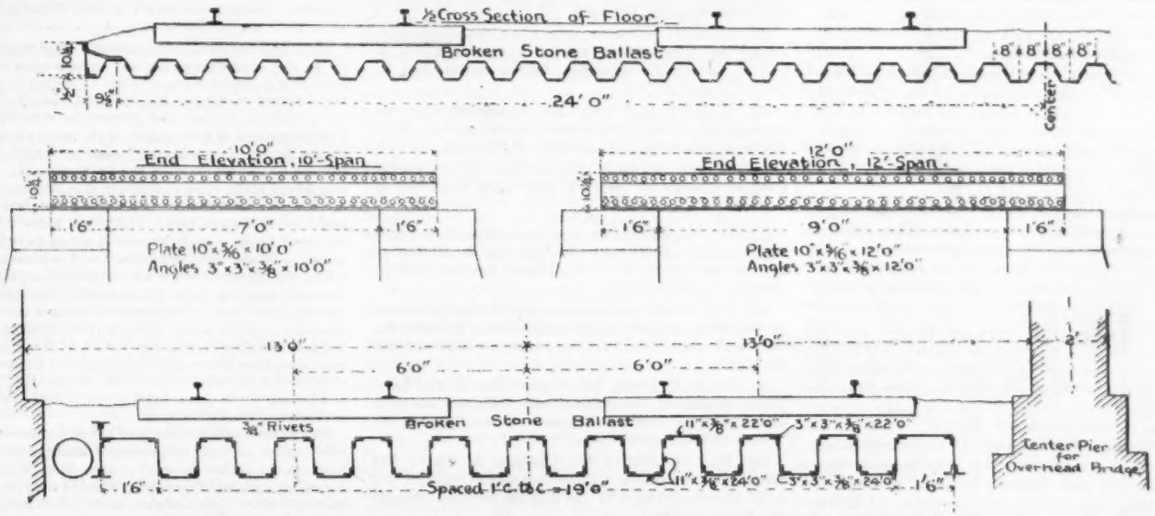
Steel and iron expand and contract in our climate at the rate of about ⅛ in. per 100 ft. from a middle temperature of 50° Fahr., or 1 in. per 100 ft. between the extremes of 150° Fahr. This would amount to 28 or 30 ins. in the 2,850 ft. span, provided the span were independent of the shore spans, 1,500 ft. long. But such is not the case. Here the length of the whole cable, from anchorage to anchorage, must be taken as changing its length and concentrating the effect in the middle span.

train loads, would otherwise cause an over-straining of the cables there. It would take the form of one cable exerting a greater pressure on the tower than the other, and carrying a much greater part of the imposed loads. To avoid that irregularity, provision is made on the towers for balancing platforms, which support respectively the lower and upper cable saddles. These platforms are so balanced against each other that the cables, under any and all conditions of loading or of temperature changes, exert equal pressures, or, in other words, their reactions are always equal. One cable cannot be made to carry more load than the other. Each must carry its equal share, and over-straining of the wires is out of the question. This novel device, simple as it is, requires ingenious arrangement for its perfect working, because during erection the cable saddles must be perfectly free to turn when the cables

less shock; or if by chance it be minimized for the moment, it does not long remain so, for the reason that the two kinds of roadbeds have different coefficients of deterioration, if we may coin a phrase. It is one of the most important merits of this form of floor that by permitting a continuous coating of ballast under all parts of the track this difficulty is done away with,—a merit which practical trackmen will appreciate better than distinctively bridge engineers, but which all engineers can appreciate. We believe it to be only a question of time when solid bridge floors will be preferred and used by all first-class lines, for this reason alone; but there are also other good reasons in their favor.

The Sumatra Railway.

In the central part of the island of Sumatra is an extensive coal field, the coal of which is of good quality and lies near the surface. It is of great importance to shipping and to the industries of the Dutch colonies; but improved means of transport were required to develop it. The mines at Ombilien are 48.36 miles in a direct line from Padang; but there is a range of mountains which necessitates a considerable detour, and the Dutch Government appointed an engineer to locate a line from the port to the mines. From the sea a plain extends to the base of the mountains, a distance of about 34.72 miles, where the elevation is 492 ft.; on the other side of the range is a plain at an elevation of 1191 ft., descending to 682 ft. at Ombilien. But opposite Padang the mountains are of considerable altitude, so that a circuitous route was required on both sides of the range to reach a pass with an elevation of 2,526 ft. above the sea. M. CLUYSENAER, the engineer, laid out a line crossing the mountains with maximum grades of 2½ per cent., requiring numerous curves and making a considerable development of the line; the estimate of cost was very high, and the Government hesitated to carry out the work. The engineer then investigated the rack-rail system and the Riggenbach (or Marsh) system of ladder rack was adopted, the maximum grades being increased to 5 per cent. From Padang the line runs with easy grades through a fertile country to the town of Kayocotanam, a distance of 34.72 miles, where the rack-rail section of 16.42 miles begins, with grades of 4 to 5 per cent.; this section crosses the range and connects with a second easy line 39.06 miles long running to the coal field. The gauge is 1 metre and the track is laid with steel ties of the Post type. The level sections are operated by four ordinary engines, and the rack section by four cog-wheel engines weighing 20 tons each; two engines can take a train load of 250 tons, and in order to relieve the strain on the couplings, one engine is placed at each end of the train. The speed on this is about 6¼ to 7½ miles per hour. The cost was about $32,256 per mile for 73.78 miles of ordinary line, $2,380,000; and $780,000 for the rack section; total cost, $3,160,000.



Solid Iron and Ballast Bridge Floors for Small Structures, N. Y. C. & H. R. R. R.

WALTER KATTÉ, Chief Engineer. GEO. H. THOMPSON, Bridge Engineer.

The cables rest on the towers in large saddle castings on steel balls, and can move. As a matter of fact, the cable bearings could with perfect safety be made rigid, because the steel towers need to bend only about 8 ins. either way from the middle temperature to accommodate the changes or length in the cables. The bending strains from this movement in the towers are comparatively very small. The cables of the end spans do not change their form from temperature effects; they are free from temperature strains. The effect is all in the middle span, with the result of a lowering of the structure at the middle of about 4 ft. in summer from what it is in April or October, and a raising of 4 ft. in the winter time, or 8 ft. between the extremes. The Brooklyn Bridge rises and falls 2½ ft., or 5 ft. in all. The change is so gradual that it cannot be observed with the naked eye.

The resulting changing curve of the arch causes strains which can be accurately calculated and provided for. For an arch rib with two parallel members as in this case, the bending strains are largest at the middle of the middle span, and decrease to zero at the towers. The tension in the cables from the loads upon it is smallest at the middle and largest near the towers. It varies about ten per cent.

The wire cables must, for practical reasons, be made of the same diameter throughout, proportioned for the largest tension near the towers. There would therefore be an excess of strength of ten per cent. at the middle of the span. It so happens that the strains in the middle, caused by temperature changes, require a similar increase in the sectional area of the cable at the middle, so that the above mentioned excess will be convenient to meet it.

The increase of section for temperature strains is an important economic question, which is solved in the design without requiring extra material in the cables. But there is another difficulty to be provided for: A ribbon arch can act as we have assumed only if it is free to turn as on a hinge on the towers. Not only temperature effects, but also all

are swung from a vertical to their final inclined position.

(TO BE CONTINUED.)

Solid Bridge Floors.

The New York Central & Hudson River Railroad has taken a leading part in the movement, which we are glad to see is daily gathering force, to substitute something safe and solid for the murderously light and open floors which have been, and still are, too common in this country. Next week we shall give some further illustrations of the kind of floors they are now using for larger spans, with some notes in regard to the pros and cons of such floors by Bridge Engineer GEO. H. THOMSON, of the N. Y. C. & H. R. R. R. In the meantime, we give some illustrations showing what this company is doing in the way of eliminating the smaller openings, which it ought never to be forgotten are really quite as dangerous to derailed trains as the larger ones.

The top section shows a floor built of Pencoyd standard heavy trough sections, weighing 25 lbs. per square foot, and fastened together by a single row of rivets; this form of floor is found to be the cheaper for small spans. The lower section shows half of the four-track bridge over the 165th St. sewer; the total length is 24 ft.; 21 ft. clear span, 2 ft. depth of floor. The cost, including ballast, etc., was $500 per track, being considerably heavier and more expensive than the upper section. The floor is built up in the same way as the solid floors for bridges, except that in the latter case the troughs are transverse to the track. The two elevations, given between the two sections, show short spans of similar floors; but for such spans it has been found more economical to use the V troughs.

Every experienced engineer of maintenance of way knows how extremely difficult it is to secure and maintain such perfection of surface that the transition from ballasted track to wooden bridge floors and vice versa shall be smooth and without shock. In fact, it may be laid down as a universal rule that the transition is never without more or

Pittsburg's Exhibit to the Pan-American Congress.

A very interesting exhibition was got up on short notice by the manufacturers of Pittsburg for the entertainment of the delegates to the Pan-American Congress. The Thomson Electric Welding Co. made a specially fine exhibit of their machines for electric welding, showing three machines in actual operation, besides a great variety of samples of the work done. The Thomson-Houston Electric Co. also had a large and well-arranged exhibit.

The Charles Munson Belting Co. showed a mammoth belt 100 ft. long, 42 ins. wide and weighing 850 lbs. The belts of this company were also used to drive the Westinghouse dynamos.

The Westinghouse exhibit was an excellent one in every detail. Besides the electric apparatus and steam engines, the automatic quick-acting air brake and the Westinghouse train signal were exhibited and attracted much attention.

But the most notable and novel exhibit of all was the display of aluminum made by the Pittsburg Reduction Co., for it was such an exhibit as has never before been made. There were 5-lb. ingots enough in one pile to make the whole mass over a ton in weight. A block of the metal near it had a bulk of 1 cu. ft. and weighed 150 lbs.

The important uses of the new metal were shown by various manufactured articles. The printed business cards of the company are made of sheet aluminum rolled to a thickness of 6-10,000 of an inch. Books of aluminum foil were shown, suitable to replace gold foil and silver foil for many decorative purposes. In table-ware, spoons, knives, and forks were shown; and the metal is undoubtedly destined to replace silver in many cases, especially for the heavier articles for which plated ware is now popular.

Buttons, medals, and other similar forms of the metal were also exhibited; but of more intesest to mechanical engineers were the specimens of wire, bars, rods, and gear wheels for light machinery. The company reports an enormous influx of orders since it made the recent reduction in the price of the metal to $2 per lb.

On the evening of Nov. 7, the guests were treated to a display of natural gas pyrotechnics from four 4 in. stand-pipes, each sending a jet of flame 50 ft. high into the air. A pipe was also carried out into the river and the escaping gas ignited at the surface of the water, forming great sheets of flame. To heighten the effect and give variety of color in the display, the experiment was tried of injecting solutions of pyrotechnic chemicals into the gas pipes. The result was eminently successful. The current of the gas in the pipe was sufficient to take up the chemicals and throw them into the flame issuing from the mouth of the jet, giving a variety of color unexceiled by any displays with the usual pyrotechnic materials.

Besides these various displays the visitors were taken to the principal Pittsburg manufactories, and given an opportunity to see the varied industries in actual operation, a sight more instructive, though perhaps less entertaining, than the grand display of the evening.

THE MANHATTAN ELEVATED RAILWAY COMPANY in the year ending Sept. 30, 1889, carried 179,497,433 passengers and had gross receipts of $9,080,880. Operating expenses and taxes amounted to $5,422,394, leaving $3,658,486 as the net earnings. The number of passengers carried by the different lines were as follows:

	1888	1889.
Second Avenue line	32,290,953	33,111,925
Third Avenue line	69,308,400	69,924,720
Sixth Avenue line	53,115,905	58,339,410
Ninth Avenue line	17,814,411	18,131,368
All lines	171,529,789	179,497,433
Increase per cent		4.64
Total passengers carried to Oct. 1, 1889		1,372,920,332

The enormous growth will be better understood by comparing with 1885, when the traffic was only 103,355,000 instead of 179,497,000, an increase in 4 years of 73.67 per cent., or 14.80 per cent. per year average. The ultimate limit is now nearly reached, however, without some radical enlargement of capacity.

PERSONAL.

Mr. MARSHALL M. KIRKMAN has been elected Second Vice-President of the Chicago & Northwestern Ry. Co.

Mr. THOMAS CORNELL, of Rondout, N. Y., has been elected President of the Delaware & Otsego Ry. Co.

Mr. JOHN T. MCBRIDE has been appointed Superintendent of the Chicago & Great Western.

Mr. C. MEYNAN, of Pittsburg, has been chosen President of the Pittsburg, Cannonsburg & State Line Railway.

Mr. J. M. FLOESCH, for the past eight years Assistant Chief Engineer of the Buffalo, Rochester & Pittsburg Ry. has been appointed Chief Engineer of the Johnsonburg & Bradford Ry., now under construction in Pennsylvania.

Mr. W. F. JORDON has been appointed Assistant Chief Engineer of the Buffalo, Rochester & Pittsburg Ry. to succeed Mr. J. M. FLOESCH.

Mr. BRADLEY BARLOW, who some years ago purchased the Southeastern Ry. of Vermont, which is now a part of the Canadian Pacific system, died at Denver, Col., recently.

Mr. K. H. WADE has been appointed General Manager of the Atchison, Topeka, & Santa Fé R. R. in Southern California, to succeed Mr. D. MCCOOL.

Mr. DAVID A. HOPKINS, at one time General Manager of the New Jersey & New York R. R., died at Park Ridge, N. J., Oct. 31.

Mr. E. W. COTTRELL has been appointed Land Commissioner of the Detroit, Mackinac & Marquette road, as successor to Mr. O. W. STRONG, who had held the position for many years.

Mr. J. D. SPRINGER has been appointed Assistant to the President of the Atchison, Topeka & Santa Fé. He was formerly General Counsel for the Minneapolis & St. Louis.

Mr SIMON C. LONG, late Supervisor of the Lancaster division of the Pennsylvania Railroad, has been promoted to be Assistant Engineer of the Philadelphia, Wilmington & Baltimore Ry.

Mr. H. L. EVANS, of the Chicago & Alton, has been appointed Assistant Superintendent at Chicago. He is to have supervision of the business between Chicago and Mason Bridge.

Mr. W. A. LUTES has resigned his position as Superintendent of Bridges and Buildings of the Southern Pacific, at New Orleans, La., to accept the position of Superintendent of the Merchants' Terminal Bridge and Railway at St. Louis, Mo.

Mr. P. W. GRUBBS, who has been Acting Superintendent of the Richmond Union Passenger Ry., has been relieved by Mr. R. W. TAYLOR, who has been appointed Superintendent of the road as well as Superintendent of the shops of the company.

Mr. JOHN N. OSTROM, C. E., late of the Detroit Bridge Works and bridge engineer of the Chicago, Burlington & Quincy and the Atchison, Topeka & Santa Fé railways, has opened an office at 108 Broadway, New York, as a Consulting Engineer for bridges, viaducts, roofs, and foundations. Mr. OSTROM's last work was the erection of the Kentucky River cantilever bridge.

Mr. C. C. WHEELER, formerly General Superintendent of the Chicago & Northwestern, has opened an office in the Phœnix Building, Chicago, and will make a specialty of examining railway properties and making estimates on the value and cost of constructing projected lines.

Mr. F. HUSSMITH has been appointed Master Mechanic of the International & Great Northern, in the place of Mr. S. H. SPANGLER, resigned. Mr. C. F. MATLOCK is appointed Resident Engineer, vice Mr. W. E. BAKER, resigned. Their headquarters will be in Palestine, Tex.

HON. WM. WINDOM, Secretary of the Treasury, has resigned his position as President of the Winona & Southwestern Ry. Mr. H. W. LAMBERTON has been elected President and Mr. V. SIMPSON, Vice-President. They, with Secretary THOS. SIMPSON, Treasurer M. G. NORTON, E. S. YOUMANS and CHAS. HORTON, constitute the Executive Committee.

General Manager HARAHAN, of the Chesapeake & Ohio, has appointed Mr. H. R. DILL Superintendent of the Huntington Division, to succeed Mr. M. B. CUTTER, who has resigned to go with the Wisconsin Central. Mr. SAMUEL I. MAYER, in addition to his duties as Superintendent of the Peninsular Division, will perform the duties of Superintendent of the James River and Richmond Division, with the title of Acting Superintendent, vice Mr. H. R. DILL, transferred.

Dr. RUFUS W. GILBERT, to whom more than to anyone else we owe our present system of rapid transit, was a surgeon during the war, first on the staff of Gen. JOHN A. DIX, and then on that of Geo. GEORGE H. THOMAS. After the war he came to New York with his plan for "a railway in the air," as it was termed by the doubting Thomases of that day. He struggled for years with poverty and against public opinion; and after he at last succeeded in getting a charter from New York State, it was years again before he could secure the capital to build even part of his proposed system; and this end was then only attained by an almost complete sacrifice of his personal interest in his patents. All that Dr. GILBERT secured for his 24 years of toil was $32,000 in stock, out of $20,000,000 capital, and the office of consulting engineer to the road for life, at $2,500 per annum only,—an office that he held for a "life term" of two years.

BOOK REVIEWS.

A Practical Treatise on Bridge Construction; Being a Text-Book on the Design and Construction of Bridges in Iron and Steel. By T. CLAXTON FIDLER, M. Inst. C. E. London: Charles Griffin & Co., 1887. Octavo, pp. xxiv, 432, with two ve plates.

This book contains much valuable information on the subject of bridge construction, but a large part of it is presented in such a manner as not to appeal to our sense of the fitness of things. For example, instead of regarding a truss as a truss, and proceeding directly to compute its stresses, it is supposed to be made up of several simple trusses or "systems," each of which transmits stresses to the other, from the 1st to the nth. Locomotive wheel loads, now commonly specified in this country, are not used for stress computations, but uniform panel loads are employed. Although plate girders are discussed, there is no information given as to the determination of the spacing of rivets or the arrangement of stiffeners. Riveted joints are computed merely for tension and shearing, little being shown concerning bearing stress on rivets. Pin-connected bridges receive more attention than is usual in books published in England; but how the sizes of pins are computed is not stated, except that it is to be inferred from the discussion that they should be treated like rivets. Evidently the idea of computing a pin like a beam under flexure has not yet reached our English cousins.

Two entire chapters and four plates are devoted to the elucidation of the "comparative anatomy of bridges," in which the author does not confine himself to existing forms, but exhibits types that, although possible, are quite impracticable. For instance, an inverted Bollman truss would be a curiosity. The arrangement of the genera and species in this classification does not correspond with that of biologists, who, we believe, proceed from the simple to the complex, for we find the suspension bridge with simple cable placed higher and later in the scale than the modern cantilever with a central span.

The work is divided into four parts. Part I. treats of elementary statics, including graphic representations of moments and shears. Part II. discusses the general principles of bridge construction, which includes the comparative anatomy, an excellent chapter on the theoretical weight of bridges, the subject of deflection and continuous girders. Part III. treats of the strength of materials, the discussion of columns being very detailed and interesting; the subject of the deflection of columns in particular is handled in a very able manner. Part IV. has for its title "The Design of Bridges in Detail," and this from our point of view is disappointing, it being more in the nature of a general discussion of the economy of different systems than the presentation of methods of design for particular cases. This discussion contains, however, much valuable matter, and the conclusions of the author seem in general to be sound and in accordance with the best practice.

It is an interesting fact that American types of bridges, as well as individual structures, are more frequently referred to in the book than are European bridges. This will tend in some degree to remove from the minds of "the colonists" that distrust of American bridge structures which one of our English contemporaries has at times sought to inculcate. The author's comparison of the great Cincinnati and Kuilemberg bridges shows that the use of eye bars instead of riveted tension members in the former results in a saving of 336 tons of metal. The economy of American bridges, he states, may in some degree be due to the skill evinced in the outline design, and partly also to the adoption of a liberal depth; but in a much greater measure it is due to the saving of waste material in the joints, effected by the economical character of the details.

PUBLICATIONS RECEIVED.

—*Practical Hydraulic Formulæ for the Distribution of Water through Long Pipes.* By E. SHERMAN GOULD, M. Am. Soc. C. E. New York, Engineering News Publishing Co., 1889. Cloth, 12mo., 61 pages.

The use of "formulæ" as the plural of formula, although entirely proper in Latin, is not in good taste when it is used as an English word. The English plural of formula is *formulas*, and we trust that our correspondents who use the word will hereafter govern themselve accordingly.

The contents of this useful little book first appeared as a series of articles in the columns of this journal, and are now republished with a few corrections and additions. It establishes systematic methods for tracing the hydraulic grade line under the different circumstances likely to occur in practice, and gives solutions of a large number of practical problems relating to the determination of the sizes of pipes for carrying given quantities of water under given needs and pressures.

—*The Judson System.*—Illustrated pamphlet issued by the Judson Pneumatic Street Railway Co., 45 Broadway, New York: 20 pp., 11¼ x 9 ins.

The pamphlet contains a very complete description of the Judson "threadless screw" system of traction, described in ENGINEERING NEWS, July 13, 1889. A report made by MR. ROBERT GILLHAM, Chief Engineer of some of the Kansas City cable roads, is given in full together with comparative estimates of cost of construction and operation. As stated in our article referred to above, the principle involved is a novel and interesting one, and it is to be hoped that a practical trial may be made of it.

—*The Whistle Signal*, a Plea for the More Safe Management of Railroads. By ROBERT BARCLAY, A. M., M. D., Consulting Aural Surgeon to the Hospital Department of the Missouri Pacific Railway. Pamphlet, 8 pp.

This is a reprint of a paper read before the National Association of Railway Surgeons last May. The author sums up his recommendations as follows:

All applicants for employment in the machine shop or on the road, before being engaged, should be pronounced duly qualified by the aural surgeon of the company.

All candidates for promotion from the machine shop to positions on the locomotive-engine, before receiving promotion, should be pronounced duly qualified by the aural surgeon.

No locomotive-fireman should be promoted to the position of engineer until his fitness for the place shall first have been certified by the aural surgeon.

All employees, in any positions whatever in the machine shop or on the road, in consequence of whose deafness, loss of life, limb, or property might occur, should report at stated intervals to the aural surgeon for his examination.

—*Highway Improvement.* An address delivered by Col. ALBERT A. POPE before the Carriage Builders' Association, at Syracuse, N. Y., Oct. 16, 1889. Published in pamphlet form.

A very readable but general address on this subject without detail or statistics. A scheme is briefly outlined which commences with a commissioner of highways, in the Agricultural Department, with a staff of consulting engineers, and ends in State highway districts, of counties or townships, under the charge of overseers of construction and repair. But the one point in this projected improvement in highway maintenance that is worthy of note is the suggestion that, before any permanent and extended system can be put into force, the importance of the situation must be recognized by the national Government, and a national system established by Congress.

—*Everybody's Hand-Book of Electricity*, with Glossary of Electrical Terms and Tables for Incandescent Wiring. By EDWARD TREVERT. Lynn Book Agency, Publishers, Lynn, Mass., 1889. 8vo. 120 pp. illustrated. Price, 25 cts.

As the author states in his preface, this is a brief outline of the late rapid advances in electrical science and is a compilation from a number of the later authorities on this head. It is solely for popular use, but is well worth its price.

—*Thermo-Dynamics, Heat, Motors, and Refrigerating Machines.* By Prof. DE VOLSON WOOD, Stevens Inst. Tech. 3d, edition, revised and enlarged. New York, John Wiley & Sons. 8vo, pp. 452, 96 cuts. $4.50.

Some important additions have been made to this edition of this excellent work, including a "Saturated Ammonia" table corresponging to the usual "Saturated Steam" table, compiled from formulas determined by the author. The changes seem hardly sufficient to call for a new review from us, but the work is a most excellent and valuable one.

—*Report on the Irrigating and Reclaiming of Certain Desert Lands in Idaho*, and other projects connected therewith, by A. D. FOOTE. [Report to the Idaho Mining and Irrigation Co.] 4to pamphlet; pp. 48.

An excellent technical report on a large project for the irrigation of lands along the Snake and Boise Rivers in Southern Idaho, which we hope to review more fully.

—*Civil and Mechanical Engineering Popularly and Socially Considered.* By J. W. C. HALDANE, C. E. and M. E. E. & F. N. Spon, London and New York. 8vo. pp. 490, 12 plates. $4.50.

An interesting and readable book in a somewhat new field, which we hope to more fully review at a later date.

—*Engineer's Report on the Taking of the Waters of Skaneateles Lake by the City of Syracuse for a Water Supply.*—By STEPHEN E. BABCOCK, C. E., 1889.

A lengthy and detailed report, opposing the use of the Skaneateles Lake water for the Syracuse water supply, and also opposing the diversion of water from the Jordan level of the Erie Canal.

TRADE PUBLICATIONS.

—*The Short Electric Railway Co.*, Cleveland, Ohio.

A handsome descriptive catalogue of the electrica appliances made by this firm. The Short system of electric railways uses overhead wires, in series, with no rail return, and in a parallel system. The overhead supports employed are of a very substantial and durable design, and all of these are finely illustrated in this publication.

—*The Gaynor Rapid Fire Alarm System*, for Police and Fire-Patrol Signal Apparatus. Gaynor Electric Co., Louisville, Ky.

Describes and fully illustrates the apparatus of this extensive firm of manufacturers of fire-alarms and police-signals. The act of unlocking the door of the street box transmits the signal in this device, and saves the fraction of time required by other inventions which operate by the opening of the door itself. Other novelties are described and recommended to the notice of town authorities using or about introducing electric fire and police signals.

—*The New American Turbine.*—Illustrated catalogue issued by the manufacturers, Stout, Mills & Temple, of Dayton, O., also manufacturers of flour, paper, and pulp mill machinery. Size, 8¾ x 5¾ ins., 120 pp.

This catalogue contains a description of this turbine with notes on the construction of head races, flumes, etc.; horse power, discharge of water through apertures, tests of the machine, and various applications of the same, together with a number of testimonials. Price lists of gearing, shafting, and other appliances are given. Also some of the tables of areas of circles, weight of materials, etc., which are now so generally appended to trade catalogues.

—*Steam Boilers.*—Pond Engineering Co., St. Louis, Mo. Pamphlet, 8¼ x 5½ ins., 32 pp.

This is an illustrated pamphlet giving particulars of different kinds of boilers, notes on specifications and construction; tables of heating surface, steam pressure, chimneys, etc.

—*Catalogue No. 8, Ingersoll-Sergeant Rock Drill Co.*—New York, 1889. 4to, 184 pp.

This is the fullest, best illustrated, and most useful of the catalogues issued by this company. It deals with almost every tool or appliance used in mining, tunnelling and quarrying, giving dimensions and prices, and an excellent cut of the tool described. It is one of those things that no man can afford to be without who wants to know all about the various articles of contractor's plant described.

—*Catalogue of the Roney Mechanical Stoker and Smokeless Furnace*, Westinghouse, Church, Kerr & Co., Manufacturers, 17 Cortlandt St, New York.

A very handsomely illustrated description of this useful appliance. The stoker is a simple attachment to steam boilers which receives the fuel in bulk and, without further handling, feeds it continuously and at any desired rate to the furnace. The smokeless furnace is a necessary part of the stoker and is equally simple and efficient. The chief claim made is based upon economy of fuel, as cheaper coal can be used and labor saved in handling. This catalogue, which can be had on application, fully describes and illustrates the working of the machine.

SOCIETY PROCEEDINGS.

Engineers' Club of Philadelphia. — The regular meeting was held Nov. 2, President WM. SELLERS in the chair.

The Secretary presented, for Mr. EDWARD HURST BROWN, a description of "Driving Piles by Water." There was some discussion by Mr. FREDERIC GRAFF and Prof. I. M. HAUPT.

Mr. P. F. BRENDLINGER presented a very full and illustrated paper on "The Grout Pump and Methods of Grouting the New York Aqueduct." There was an extended general discussion of matters concerning this engineering structure.

HOWARD MURPHY,
Secretary and Treasurer.

Engineers' Club of Cincinnati.—The fifteenth regular meeting of the club was held Oct. 24. A committee of three was appointed to confer with the committee of the American Society of Civil Engineers in relation to the proposed uniting of the various engineering societies of the country.

In the absence of any prepared paper for the meeting the members discussed the accident which occurred recently at the inclined plane extending to one of the hilltops in the city, by which several lives were lost. The proper connection of cable to car, the use and reliability of various clutch and brake devices, etc., were discussed at some length.

Engineers' Club of St. Louis. — At the meeting on Nov. 6 Mr. WINTHROP BARTLETT presented an informal paper on the "Olive Street Cable Road." The total length is 9.6 miles. The conduit is 39 ins. deep; the Johnson rail, weighing 65 lbs. per yard, is used. The speaker gave the particulars of numerous details of construction. The road was built at the rate of 274.2 ft. per day, counting every day between the time of starting and finishing. Interesting information on the subject of the horse-power required under varying conditions of service was given. The enormous fluctuations of power were shown by an indicator card in which the power varied from 136 H. P. to 609 H. P. within one minute. The percentage of power required to drive the cable only, as compared with the total power used, was about 50 per cent., much lower than on other roads. A number of practical points of experience were explained, with details of improvements that had been made. Messrs. RUSSELL, JOHNSON, SEDDON, and HUBBARD took part in the discussion of this paper. The hour being late, it was ordered that Prof. POTTER'S paper on "Fuel Gas" be made the special order of the next meeting, Nov. 20.

WM. H. BRYAN, *Secretary.*

The Engineering Association of the Southwest.—A circular letter from this new organization, having headquarters at Nashville, Tenn., gives the following details in regard to it:

DEAR SIR: Pursuant to a call, dated Sept. 7, issued by a previously appointed committee of local engineers and addressed to the leading representatives of the engineering and allied professions in Tennessee and neighboring States, a meeting was held, Sept. 19, at the Maxwell House, Nashville, Tenn., for the purpose of taking final steps toward the formation of an engineering or technical society of the Southwest, with headquarters at Nashville. The responses to the call, by both personal attendance and letters assuring co-operation, were so numerous and so hearty as to leave no uncertainty as to the desirability or feasibility of the proposed enterprise. Accordingly a permanent organization was effected, a Constitution adopted, a President and a Secretary elected, a committee to nominate officers for the ensuing year appointed, and an Executive Committee appointed to complete the arrangements for the establishment of the Association.

The following are the salient features of the form of organization effected, full particulars of which may be found in the Constitution, a copy of which is herewith sent you:

1. A membership comprising engineers of the various branches, architects, chemists, metallurgists, electricians, superintendents, etc., without restriction as to residence.

2. The establishment of society headquarters at Nashville, always open, comprising a technical reading room, office and meeting room.

3. A provision for the representation on the Board of Directors of the membership from each State.

4. The holding of annual and monthly meetings for the reading of technical papers, discussions, at Nashville and other prominent points, to be chosen.

5. The submission of matters of importance, such as nominations and election of officers and members and amendments to the Constitution, to the non-resident membership by means of written communication, letter ballots, etc.

6. The rating of non-resident assessments and dues below those for residents.

The first annual meeting of the Association will be held at Nashville, Tenn., on Thursday, Nov. 21, at 7.30 P. M., at which the annual business of the Association for the ensuing year will be transacted, including the election of a full board of officers and at which a full attendance of the original members is earnestly desired.

Persons to whom this letter is addressed and who, prior to the annual meeting, signify, on the enclosed blank, their intention to become Members of the Association, will be classed as original members to whom the constitutional formalities regarding election to membership do not apply. Each duly enrolled original member will receive, prior to the annual meeting, a letter ballot, prepared by the nominating committee and containing the nominations for officers, which ballot may be deposited at the election in person or sent by mail.

The membership fees for the coming year have been adopted as follows:

	Resident Fees.		*Non-Resident Fees.*	
	Entrance.	Annual.	Entrance.	Annual.
Members	$5.00	$5.00	$5.00	$5.00
Associates	4.00	4.00	4.00	4.00
Juniors	3.00	4.00	3.00	3.00

Correspondents are subject to no fees.

The entrance fee is due at the time of entrance and one-half the annual dues for each grade of membership are due at the opening of the annual meeting, or the annual dues for the whole year may be paid in one remittance, if preferred.

You are very cordially invited to become an original Member, by filing and returning to the committee the enclosed blank.

W. F. FOSTER, *President.*
HUNTER MCDONALD, *Secretary.*

OLIN H. LANDRETH, *Chairman*
R. C. LEWIS
W. B. ROSS
} *Executive Committee.*

ENGINEERING NEWS

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Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

Coming Technical Meetings.

American Society of Mechanical Engineers. New York.—Next meeting, Nov. 18 to 22. Secy., F. R. Hutton, 64 Madison Av.

Western Railway Club, Chicago, Ill.—Next meeting, Nov. 19. "Compound Locomotives;" "Best Metal for Brake Shoes." 8 o'clock the Phœnix Building.

Engineers' Society of Western Pennsylvania.—Next meeting, Nov. 19. Secy., S. M. Wickersham, Pittsburg, Pa.

Engineers' Club of St. Louis, Mo.—Next meeting, Nov. 20. "Compound Engine." F. F. Furney; "Railway Inclines," I. A. Smith. Secy., W. H. Bryan, 809 So. 7th St.

American Society of Civil Engineers. New York.—Next meeting, Nov. 20. "Formulæ for the Flow of Water in Pipes," E. B. Weston. Secy., John Bogart, 127 E. 23d St.

Boston Society of Civil Engineers.—Next meeting, Nov. 20. "The Freezing Process of Making Excavations in Wet Ground," E. L. Abbott. Secy., S. E. Tinkham, City Hall.

New York Railway Club.—Next meeting, Nov. 21. Rooms at 113 Liberty St.

Engineers' Club of Kansas City, Mo.—Next meeting, Dec. 2. "Snow Plows," F. E. Sickels. Secy., Kenneth Allen, 209 Baird Building.

Western Society of Engineers, Chicago, Ill.—Next meeting, Dec. 4. Secy., J. W. Weston, 78 La Salle St.

Association of Civil Engineers. Dallas, Tex.—Next regular meeting, Dec. 6. Secy., E. K. Smoot, Elm and Austin Sts.

Engineers' Club of Philadelphia, Pa.—Next meeting, Dec. 7. Secy., Howard Murphy, 1122 Girard St.

Civil Engineers' Club, Cleveland, O.—Next meeting, Dec. 9. Secy., C. O. Palmer, 21 Cedar Ave.

New England Railway Club, Boston, Mass.—Next meeting, Dec. 11. Rooms in the United States Hotel.

Civil Engineering Society (Inst. of Technology), Boston, Mass.—Next meeting, Dec. 12. Secy., Clement March.

THE formal starting of work on the Nicaragua Canal, which took place Oct. 22, but of which we first get details this week, is an event which is likely to have a more far-reaching effect on the industrial future of the world than any other which has happened in many years; certainly its effects are likely to be far more important than the opening of the Suez Canal, for many reasons. That the work will be carried forward continuously to a triumphant conclusion, failing some temporary check from a great financial panic, seems to us almost a certainty; nor do we see any real reason to doubt that the present estimates of both time and money will prove sufficient. Results under such scatter-brained management as the two LESSEPS enterprises have had are no fair criterion of what is to be expected on a work like this, which has been properly and carefully surveyed and designed, and which has very great advantages of climate, water supply, and material which the LESSEPS enterprises have lacked. Of course for a few months, work must be carried on on a comparatively limited scale, to be carried on economically. Certain preliminary work, like the supply of Greytown with water, the construction of a railway over the divide, and the opening of the harbor, require time rather than a large force for their completion; and it would be folly to attempt to throw a large force or a large plant upon the ground before they have been completed; but the traffic in sight for the canal makes its financial future so secure that we shall expect with confidence to hear within a few months that the main contracts have been let, and that the financial arrangements for the capital for construction are satisfactorily completed. That the canal will profoundly affect for good the future of the whole Pacific coast, and in fact every part of the "Three Americas," is very clear.

ANOTHER "local engineering society" has been formed at Nashville, Tenn., as noted elsewhere, and it is a fact whose significance should not be lost sight of by members of the Am. Soc. C. E. that every one of the six men who have taken the leading part in organizing it is already an M. Am. Soc. C. E. We understand that very liberal measures, looking to an "affiliation" of the local organizations with the Am. Soc. C. E., are in contemplation by the committee which is now preparing a revised form of constitution for that body, and if such measures are needed, we hope they will be taken; but there are a few fundamental facts which should not be forgotten.

It is eminently desirable that there should be an appropriate grade in a national engineering society for every person who has distinctly entered upon the practice of the profession and is in the line of promotion. But by raising the qualifications for the grade of Member so that only those of considerable age and professional standing can aspire to it; lowering the qualifications and dues for the grade of Junior so that any one actually at work in engineering can enter it; creating the intermediate grade of Associate Member to fill the wide gap thus created between Member and Junior, and retaining the present very elastic grade of Associate for men of scientific pursuits who yet do not practise as engineers, there is a place provided within the Society for every man who is likely to seek or be granted membership in any local organization. Why, then, seek to "affiliate" with the Society a man or a body of men who do not wish to become an integral part of it under these very liberal conditions? We do not believe in even the attempt to do so. It would be introducing a source of weakness and not of strength. Remembering that the strength of all these local organizations lies in those who are already members of the Am. Soc. C. E., we do not believe there is the slightest need for more radical measures to secure their rapid conversion into local "Associations" or "Sections" of the Am. Soc. C. E., if certain reasonable financial concessions, recognizing past entrance fees, etc., paid to local organizations, be also granted for a time when a change in the form of a local organization is proposed.

THE Committee on Revision of the Constitution of the American Society of Civil Engineers have done a very sensible thing in their progress report, abstracted last week, by which they made no attempt to submit a revised constitution in the first instance, but instead thereof reported merely an amendment to the amending clause of the present constitution by which it is made possible to submit amendments to the constitution a few weeks before the midsummer annual convention as well as before the midwinter annual meeting. This enables them to postpone until the business meeting on April 3 the submission of a revised constitution, and in the meantime they submit merely a recodification of the present badly mixed and misarranged constitution and by-laws, making no changes of substance whatever, but consolidating the two into one instrument, which is divided into appropriate articles of several sections each. This not only abolishes an entirely needless and practically unimportant distinction between "constitution" and "by-laws," but makes it possible to submit a new constitution to be voted on article by article, instead of as a whole: so that, if any one or more articles fail to command the necessary two-thirds vote, that article only fails, and the corresponding article of the present constitution will remain in force until a more acceptable substitute is prepared. Otherwise, let the new form be ever so well drawn, it would be extremely likely that one-third of the voters would find something or other to object to in it, and so vote against it as a whole, when in a vote on each single article only a trifling minority would vote against it. The need for a revision of the constitution is too great and pressing to make it warrantable to leave open so large a loophole for failure.

THE change from horse to cable power on the Broadway surface road in this city, which now seems certain to be effected in the near future, should be hailed with the greatest satisfaction by every New York citizen. The company has indeed a profitable monopoly; but it is paying into the city treasury a very large percentage of its profits, and must continue to do so.

The proper place for cable roads is in city traffic, where there are many steep grades to be overcome, or where the traffic is exceptionally heavy. The latter condition is most certainly the case on Broadway. All the cars which the cable will carry are certain to be filled during the rush hours; and with well-lit, easy-riding, and somewhat faster cars, there is certain to be a great increase in the travel on the Broadway line. The excellence of the cable system for this situation is that it costs very little to put on additional cars. If the cars are properly grouped upon the cable, so as to bring the great bulk of them to the lower end of Broadway during the rush hours, the company should be able to capture a good percentage of the through uptown travel. It is possible that with this line and the Third Avenue both using the cable system, there may be some relief to the present overcrowded state of the elevated roads, especially if other roads follow the example.

It seems quite likely, moreover, that the incidental advantages of a cable road on Broadway will be even greater than the direct gains. Unless our municipal authorities are wofully lacking in judgment, the remainder of the street will be repaved at the same time that the company lays its trench and puts its

share of the surface in order. The removal of the nuisance from the horses, and their crowded stables in the upper part of the city, will be another gain, whose value it would be difficult to estimate in money.

It is not impossible, too, that if the surface companies increase their facilities to such a point that the income of the Manhattan Elevated Company begins to suffer, the officers of that corporation may take some steps to accommodate their enormous traffic in some better fashion than is now done.

THE effort to convert Central Park into a fair ground has been formally abandoned since our last issue; and we may hope that this forever ends all attempts to convert it into real estate whenever any one wants some free for an alleged public use. It is hard to say, however, as the present ground of abandonment does not pretend to be conviction that the attempt was improper, or even hopeless, but simply that the land is "not needed," —a claim which gives no more evidence of change of heart in regard to an essentially injurious and improper effort than if a party of men proposing to rob a bank should declare that on the whole they thought they wouldn't, because they found that they could raise the money elsewhere. It is not likely that those who posed as public benefactors on the ground that they had always believed that the money could be raised elsewhere, and had always disapproved of the bank proposition, would gain very much credit thereby with the general public; nor does it appear as if a different result had followed from the abandonment of the park proposition. Taking the best possible view of it, it was "worse than a crime, a blunder," which tends to make the whole project ridiculous; and the real reasons for it are as various and incongruous as the mythical defense of the borrower of a cracked pot, which were, first, that he had never borrowed it; secondly, that it was whole when he returned it; thirdly, that it was cracked when he borrowed it. The Central Park effort is abandoned, first, because it is against the law; secondly, because the people wouldn't have it anyway; thirdly, because it was never really intended to use it, but only to frighten surrounding property holders (an idiotic as well as discreditable claim, since surrounding property holders would plainly rather have the fair in the park than on their own lands); and fourthly, that it had proved possible to "make other arrangements." The guarantee fund has grown to about two-thirds of the required $5,000,000, but the only generous and large subscription in the whole list is that of the brewing interest, $446 000. The chances of New York for having the fair at all seem small; yet it is plainly the place to hold it, if it could only be properly planned and managed.

THE Paris Exposition, now closed, has undoubtedly been the greatest of all expositions held. Roughly summarized, the record of visitors stands about as follows: Attendance 24,000,000, averaging 125,000 for each week-day and 300,000 on Sundays. The Paris omnibuses carried 15,000 000 more people than usual; the boats on the Seine, 20,000,000 more than the average, and the railways entering Paris during the six months carried 36,000,000, or 5,000,000 more than in the six months preceding the Exposition. The city gave 8,000,000 francs, but received back 9,000,000 francs in increased octroi duties. The Exposition, in the magnificence of buildings, in the excellence of exhibits, and in its commercial returns, was a complete success; and it practically warded off a financial crisis that was threatened by the almost simultaneous collapse of the Panama Canal and the failure of the Copper Syndicate and some other large French enterprises. It also proved that the Republic could hold a grander world's fair than the Empire, and by its success, it pretty effectually settled Boulangerism and the political uncertainties that immediately preceded the opening.

It proved also that exhibitions of this kind pay, when intelligently administered and located in a great center of population. The statistics above given show that it was Paris and its immediate surroundings that made the fair a success; for out of a total attendance of 24,000,000, only 5,000,000 people more than usual came to Paris by the railways; in other words, just that many above the average were especially attracted to Paris by reason of the fair. As Americans travel much more, as a rule, than do the people of the Continent, the proportion coming from a distance to any fair held in this country would doubtless be larger than it was at Paris. But the fact is evident that the larger the local population at the site of the exhibition of 1892, the greater will be the attendance, and the commercial success, and the general useful effect of such an exhibition. New York, the metropolis of the United States, is the only city within our borders answering to these requirements of population and local attractions; but New York sadly needs a little more of that energy of purpose and local pride, so characteristic of some other large cities in this country, to make available the advantages it really has.

Driving the Dynamo for Electric Lighting on Railway Trains.

In a recent issue of the *Electrical World* we find some amusing and rather sweeping statements concerning the system of train lighting in which the dynamo is driven by a belt from the car axle. On the London & Southwestern railway, in England, a system of electric train lighting is in operation in which the dynamo is driven in this manner, and that fact was brought up in the discussion on train lighting at the recent meeting of Railway Telegraph Superintendents. A correspondent of the *Electrical World* recently interviewed Mr. BAUER, electrician of the Pullman Palace Car Company, and the following is quoted as his opinion on the subject:

> Experience under various conditions has demonstrated the impossibility of securing even fair results in train lighting where the power is supplied by the axle, owing to the constant change in speed and the numerous curves found on American railways, around which the wheels will often slide without turning the axle a single revolution, thus playing the mischief with belt and armature.

It is hardly supposable that Mr. BAUER believes the coaches under his care to have the habit of frequently sliding around curves with the wheels stationary; and we conclude, therefore, that the above extravagant statement is due to carelessness on the part of our contemporary's correspondent. It may be thought that so absurd a story would not be credited by any person of common sense; but we find it reprinted in journals of much reputation in the railway field, and we deem it wise to call attention to the error lest some of our English cousins should take up the story as an instance of the fearful results which come from the American system of using liberal curvature in railway location.

The other objections made by Mr. BAUER to the taking of power from the car axle for running the dynamo were more in accordance with actual facts; but the gist of them all was that the variations in the running speed of an American passenger train, due to grade crossings, sharp curves, trestles, etc., made the system impracticable in this country.

It may be that at present electric train lighting can be most easily carried out by the use of an independent engine to run the dynamo; but that the dynamo can be successfully driven from the axle, experience on the London & Southwestern Railway fully proves. It is also true that, so far as cost of power to run the dynamo is concerned, theory points to this system as by far the most economical. Indeed, since in general every railway train runs down grade half the time, if the dynamo be run only on the down grades, we ought in theory to obtain the power to run it at no expense whatever. We do not pretend to claim, of course, that this is now or ever will be practically possible, but fortunately the advantages of running the dynamo from the car axle do not rest on this basis merely. In our issue of NOV. 2, Mr. CHAS. SELDON, Superintendent of Telegraphs of the Baltimore & Ohio, gave some figures as to the cost of electric train lighting, in which he showed that at least half the cost of lighting a train was due to the salary of the attendant required to run the engine and dynamo. Mr. SELDON thought it might be practicable to give the baggageman charge of the dynamo, and thus save most of this heavy item of expense; but in the discussion this was generally pronounced impracticable.

It seems to be pretty certain that, so long as the dynamo is run by a steam engine, an attendant will be indispensable. On the other hand, if the dynamo can be run from the car axle, it would seem as if the task of making the whole apparatus automatic should be by no means an impossible one. A pulley on the axle, a belt with automatic tightener, an automatic friction clutch connection with the dynamo, so arranged as to throw out of gear when the car runs below a certain speed, are the chief requirements for driving the dynamo; and there need be nothing so complicated about any of them as to require the attention of an attendant oftener than once a day. Again, if this be otherwise practicable, we save in weight, cost, and space by dispensing with the engine and its steam pipes, and are also much less cramped in designing the dynamo. We can make a larger, heavier machine and run it at a lower speed, and we shall then have a plant not liable to derangement, and one for which no constant attendance is required.

One great trouble with electric train lighting has been that, even with the best balanced engine, there is a great deal of vibration when run at the high speed which must be maintained in order to obtain the necessary power with the limited weight. This vibration tends to strain the car frame most seriously, and this strain may conceivably become so serious as to sensibly aid the car in leaving the rails. Any traveler by the limited trains must have observed how very noticeable the vibrations are when the train stops. The dynamo, however, is a perfectly balanced machine; and thus, by dispensing with the engine, we overcome what has been one great difficulty in the way of electric train lighting.

There are other incidental advantages to such a system, but those we have named are most important; and they are so important that until some one clearly proves this system to be absolutely impracticable, it is as deserving of a fair trial as is the system of operation by an independent engine; and a "fair" trial means repeated efforts to overcome difficulties as they develop.

Mr. BAUER thinks the frequent slackening of speed of American trains is an obstacle too great to be surmounted. But there are

great many trains now running in this country which do not slacken speed enough to make it necessary to stop a connected dynamo oftener than once in half an hour. The slackening of speed means simply that the dynamo must be stopped and started again more or less frequently. Is the task of designing a dynamo which will operate under those conditions without attention as difficult as the problem which the street car motor designers appear to have solved of making a motor which will stop and start every minute, against every degree of resistance, and which will operate where it is exposed to mud, slush, rain, and, indeed, to actual immersion in water? Is the task of designing a dynamo for this duty so difficult that it is best not to attempt it, and to forego, therefore, all the advantages to be won by its successful accomplishment? It may be so, but it is difficult as yet to see just why.

What seems to be the really serious question in this matter is whether the frequent delays to trains, while waiting for connections, etc., would often exhaust the storage batteries and leave the passengers dependent on candles for light. Of course, with the independent engine, so long as the locomotive is attached, the dynamo can be run; but with the dynamo belted to the axle, when the car is not in motion the only resource for light is the stored electricity in the batteries. It is beyond question, therefore, that a considerably larger capacity of storage batteries is required for use with this system than with the independent engine; and a larger dynamo as well, since it is running less of the time.

But it is to be remembered that the storage battery is being improved and made more convenient and economical all the time. It has already been largely used for train lighting without any dynamo on the train, the batteries being charged at the terminal points; and while there are of course many weak points in this system, so much success has already been attained that we are justified in expecting much more in the future. It certainly seems likely that with such storage batteries as are likely to be at our disposal ere long, a delayed train equipped with these batteries, in conjunction with a dynamo driven from the car axle, will endure delay for a longer period than a car lit by the compressed gas system or even than a car lit by oil lamps, provided the latter could not be refilled, as might be the case in a snow blockade. Moreover, while it is a very serious matter if the usual supply of heat be cut short, even for an hour, it is a very small evil to have the supply of light rather scant in exceptional delays, and it is so simple a matter to carry a supply of candles, and so comparatively rare for trains to be delayed en route more than a couple of hours, that we believe an otherwise acceptable system, which only provided for two hours' or so storage of light, would answer all practical requirements.

Much more might be said of the minor details of operation, some of which militate for and some, of course, against the system of driving from the car axle. But we have covered the main points, and have, we trust, at least proved that the system which has so many points in its favor is neither to be driven from the field because the wheels of American cars have a habit of sliding around curves without turning, nor because American express trains are run at somewhat more uneven speeds than are express trains on British railways. That the other practical difficulties can be overcome we do not say; but we do say there is a good fighting chance for it, and that if they were overcome, driving dynamos from the axle might furnish an ideal system of car lighting.

The Making of Great Guns.

The *London Times*, in a late issue, seriously doubts whether the 111-ton and 67-ton guns, intended for arming England's new battleships, will be worth having when they are completed. The guns have failed so frequently in the late preliminary trials that the *Times* is justified in doubting the efficiency and durability of those that have just managed to scrape through the tests. At the works of one firm alone, one 105-ton gun, one 12-in. gun, two 10-in. guns, and two 8-in. guns have been condemned under proof; and it is further reported that the 111-ton guns lately mounted on the war-ship *Victoria* are both practically *hors de combat*. If this is their record under carefully conducted tests, the conduct of these guns under rapid and continuous fire, such as will be demanded of them in the service for which they were supposed to be built, may well be doubted.

The *Times* practically charges the failure of these monstrous pieces of ordnance to the difficulty of securing in England sufficiently good metal for this purpose, and hints that either English metallurgists have not the sufficient experience and scientific knowledge which enable KRUPP or Creusot to turn out without difficulty good steel, or that English gunmakers demand more from the metal than it can safely bear. The powder in use in England has also to answer for some of these accidents by its violent and uncertain action under varying conditions. The "prism-block" and "slow-acting" powder is broken up into small fragments by frequent handling, and as a consequence becomes "quick-acting," and a 38-ton gun on the *Ajax* was lately blown to pieces, presumedly from this cause. And this same powder, if stored for any time in the hot magazine of a man-of-war, is liable to change to a violent explosive with a most dangerous detonating action. Of this dangerous powder the English use enormous, and what the French call "foolish," charges, and in the 12-in. gun dearly buy a little increase in initial velocity with 295 lbs. of powder, where the French, in an almost identical gun, only put 235 lbs. The *Times* concludes that there is something utterly and radically wrong with the whole system of gun manufacture in England. Quite a natural conclusion, since it admits at the same time that Germany and France make better guns and understand better how to handle them.

Battle-ships without guns are about as useful as would be NELSON'S old *Victory* with its 32-pounders in any modern naval demonstration. We are now building cruisers and are able to construct excellent guns of the lighter and quick-firing type to arm them with; but we are also laying the lines of battle-ships, and as they will need guns of the heaviest type, it behooves us to carefully avoid the pitfalls into which England seems to have stumbled in the manufacture of great guns. The tendency among our ordnance officers has heretofore been to adhere perhaps a little too closely and blindly to English practice in this particular, and our larger guns, authorized by act of Congress of Sept. 22, 1888, have yet to be tested. The heaviest guns in existence are the four Krupp 40 cm. (15.75 in) guns made for the Italian Government and delivered (excepting one) in 1886. The test gun has been fired 200 times, up to the latest accounts, with a 2,082 lb. projectile and a muzzle velocity of 1804 foot seconds. A maximum powder charge of 864.6 lbs. has been used, resulting in a velocity of 1876 foot-seconds and a breech-pressure of 18.9 tons per sq. in. These guns have satisfactorily filled all the demands of service firing; and as to accuracy, it was stipulated that 10 out of each 50 rounds were to be fired at a target distance of 2,734 yds., and all shots were to fall within a vertical 10.6 ft. square. A comparative table of the heaviest guns of England, France, Germany, and America would stand as follows as compiled from the reports of the United States Navy Department:

	England, Armstrong	France	Germany, Krupp	United States.
Date of Design	1884	1875	1882	1889
Calibre	16.25 ins.	16.54 ins.	15.75 ins.	12 ins.
Weight	111 tons	74.2 tons	119 tons	45.2 tons
Length, total	524 ins.	389.8 ins.	551.2 ins.	441 ins.
Length of bore, in calibres	40 Cal.	22 Cal.	31.7 Cal.	35 Cal.
Charge	850 lbs.	595.2 lbs.	727.5 lbs.	425 lbs.
Projectile	1,800 lbs.	1,719 lbs.	2,028.2 lbs.	850 lbs.
Muzzle velocity	2,148 ft. sec.	1,692 ft. sec.	1,804 ft. sec.	2,100 ft. sec.
Total energy	57,580 ft. tons	34,140 ft. tons	45,770 ft. tons	25,990 ft. tons
Perforation of wrought iron	34.1 ins.	26.1 ins.	30.9 ins.	26.7 ins.

This table would support the London *Times* in its assertion that the English gun-makers are asking more from the metal used than do the French or the Germans; and the fact is also evident that in muzzle velocity and developed energy the Americans are following the English rather than the German or French practice. A table, also lately published by our Navy Department, compares the muzzle energy per ton of gun as follows: The Armstrong 111-ton gun, 519 ft. tons; French 74-ton gun, 460 ft. tons; the Krupp 119-ton gun, 385 ft. tons; the United States 45-ton gun, 575 ft. tons. As we understand this comparison, it means that a certain amount of work is performed per ton of gun metal; and as this work means strain upon the material of the gun, the United States this time is even surpassing the English practice and far exceeding that of the Germans.

Modern guns of the types described are enormously expensive fighting machines, in the first cost of the gun and its mounting; and theoretically they are built for continuous use for a considerable time against the ships or forts of an enemy. It is not to be supposed that they are only useful in a few ornamental tests, showing abnormal energy, range or penetration of a target. And yet, according to England's own reports concerning her guns, the gain in muzzle velocity and energy over the guns of other nations is only secured at the cost of so much increased strain in the gun itself that many fail in the tests, some soon after they are put into service, and a valid doubt exists as to the future behavior of others that have only squeezed through preliminary tests. As a nation, we are very new in the art of making heavy guns of modern types: and in our present condition the experience of other nations is (or should be) as profitable to us as it is expensive to them. But to profit by the practice of others, we must carefully avoid their mistakes; and one mistake that England seems to be making—and that we are copying—is in demanding excessive work from the material at present available for gun making. Herr KRUPP may have methods of his own for manipulating his steel which he carefully keeps to himself. But if he has better steel, the endurance of his guns must be even better than the record would seem to indicate, for he certainly asks less work from his steel, per unit, than any of the other three nations named. Whatever the secret may be, Germany is so far unques-

tionably ahead in the art of building serviceable guns; and it would seem only wise to follow her lead rather than that of a nation that has so far built a class of gun that we do not want.

CORRESPONDENCE.

Determination of the Length of the Strut of a Howe Truss.

TO THE EDITOR OF ENGINEERING NEWS:—

A Howe truss panel being given by its dimensions, and the width of the strut being fixed, it has been a favorite mathematical problem to determine the length of the strut, the solution of which involves the reduction of a bi-quadratric equation. It is the object of the following discussion to show how this reduction may be accomplished both analytically and graphically, and to deduce from these methods an easy graphical method, whereby the length of the strut may be accurately determined.

In the figure let $O\,Y\,Z\,X$ represent a panel whose sides are $2\,a$ and $2\,b$. Let $a\,b\,c\,d$ be the strut whose width is c. At the middle point of $a\,d$ erect a perpendicular to N. N will be the center of the panel, and s N will be the half length of the strut, which length denote by R. Now, assuming $O\,X$ and $O\,Y$ as a set of co-ordinate axes, determine the locus of the extremity of R when $a\,d$ moves so as to have its extremities continually on these axes. The resulting locus is an ellipse whose transverse axis is a line passing through the origin and making equal angles with the coordinate axes. In the equation of this ellipse R is an arbitrary constant, and the equation represents an infinite number of ellipses depending

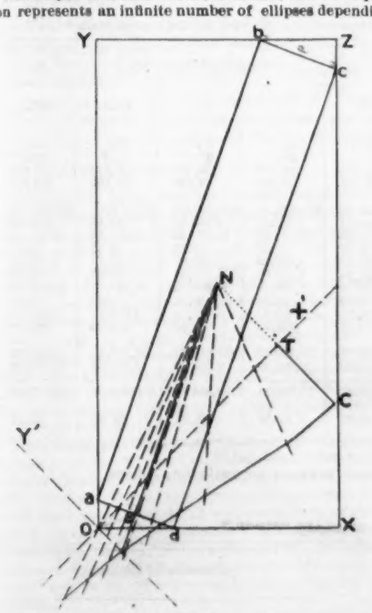


Fig. 1.

Computing Length of Howe Truss Braces.

on the value assigned to R. If the locus be made to pass through the center of the panel by substituting for x and y the co-ordinates, a and b, of that point, the resulting value of R would be the required one. Transferring the reference of the ellipse to a set of coordinate axes coinciding with the axes of the ellipse ($O\,X'$ and $O\,Y'$ in the figure) we find the equation to be

$$[R\,\tfrac{1}{2}\,c]^2\,y'^2 + [R - \tfrac{1}{2}\,c]^2\,x'^2 - [R^2 - \tfrac{1}{4}\,c^2]^2 = O \ldots\ldots \text{(A)}$$

Expanding the equation and representing by s the absolute term $\frac{1}{4}\,c^2\,[l^2 + k^2 - \frac{1}{4}\,c^2]$ we have

$$R^4 - [l^2 + k^2 + \tfrac{1}{4}\,c^2]\,R^2 + [c\,(l^2 - k^2)]\,R - s = O \ldots \text{(B)}$$

l and k being the co ordinates of N referred to the new axes.

Now write the equation

$$v^3 - 2\,(l^2 + k^2 + \tfrac{1}{2}\,c^2)\,v^2 + [(l^2 + k^2 + \tfrac{1}{2}\,c^2)^2 + 4s]\,v - c^2\,[l^2 - k^2]^2 = O \ldots\ldots\ldots\ldots \text{(C)}$$

Transforming this to another whose roots are less than those of equation (C) by $\frac{2}{3}\,(l^2 \times k^2 + \frac{1}{2}\,c^2)$ we have an equation of the form of $v^3 + q\,v + t = O$ ....(D

Solving equation (D) by Cardan's or Bombelli's formula and adding $\frac{2}{3}\,(l^2 + k^2 + \frac{1}{2}\,c^2)$ we have the roots of equation (C).

Representing these roots by $4a$, $4b'$, and $4c'$ we will have for the roots of equation (B) (since $c\,(l^2 - k^2)$ is essentially positive)

$$R = -\sqrt{a} - \sqrt{b} - \sqrt{c}$$
$$R = +\sqrt{a} + \sqrt{b} - \sqrt{c}$$
$$R = +\sqrt{a} - \sqrt{b} + \sqrt{c}$$
$$R = -\sqrt{a} + \sqrt{b} + \sqrt{c}$$

In general two of these roots will be imaginary. As seen above, the labor of analytically computing R is very great. To obtain an easy graphical solution: Inspecting equation (A) it is evident that the semi-axes of the ellipse are $R + \frac{1}{2}\,c$ and $R - \frac{1}{2}\,c$, or their difference is a constant and equal to the width of the strut. Now the problem resolves itself into finding the major axis of an ellipse whose semi-axes differ by c and which passes through the joint N. With N as a pole describe a conchoid of Nicomedes whose modulus is c and which has the axis of X' for its directrix. Its equation referred to T as a center is $x^2\,y^2 - (k \quad y)^2\,(c^2 - y^2)$. Now from a well known method of constructing an ellipse, if a line be drawn through N so that its intercept between the co-ordi-

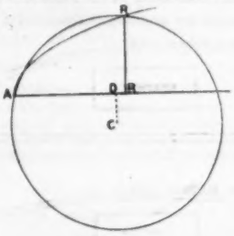


Fig. 2.

nate axes be equal to the difference of the semi-axes of the ellipse, the length of the line from N to its intersection with Y' will be the semi-major axis. Hence if we find where the conchoid given by its equation above cuts the axis of Y', we will have the solution of our problem. Substituting l for x in the equation, we obtain an equation of the fourth degree containing y which may be solved as we solved equation (A). But as before, the analytical work is tedious, whereas the graphical method is simple. The conchoid may readily be traced by a continuous movement using a grooved ruler, for sale by all instrument makers. In the absence of such an instrument draw through N several right lines and from their intersections with X' lay off distances each equal to c. A curve traced through these points will be almost a right line and its intersection with Y' may be accurately determined. From this point the length of a right line to N minus $\frac{1}{2}\,c$ will be the half length required, and the problem is solved.

Another easy graphical solution is to construct directly the roots of equation (B). Combining the equations of a parabola whose parameter is $2\,p$ and of a circle, the coordinates of the center being a and b and the radius r, we have this equation:

$$y^4 - (4\,pa - 4\,p^2)\,y^2 - 8\,p^2\,by + p^2\,(4\,a^2 + 4\,b^2 - 4\,r^2) = 0\,(E)$$

Comparing (B) and (E) we find their forms to be the same. Equating co-efficients of like powers and assuming $p = 1$, we determine the values of a, b, and r.

The parameter of the parabola being given, it is easily constructed, and then laying off $A\,D = a$ and at D erecting a perpendicular and laying off $D\,C = b$ we have the center of the circle from which, describing an arc with a radius r, the ordinates of the point of inter-section are the values of the roots of equation (B).

ALBERT M. D'ARMIT,
Lieut. of Engineers, U. S. A.

[We have seen at various times a number of solutions of this famous mathematical problem, but we do not recall any previous one so clean-cut and concise as this.—ED. ENG. NEWS.]

English vs. American Railway Practice in Mexico.

TO THE EDITOR OF ENGINEERING NEWS:—

Recent railway development in Mexico has brought into conflict the two systems of railway surveying. English money employed gives preference to Englishmen, while Americans push to the front on their merits.

The American system is not fully carried out in southern Mexico, owing to its being hampered by an English management. The English system, as conducted on some roads now building, may be briefly described as follows: As the Government subsidy is by the kilometre, distance is sacrificed for everything; not only for grades and curvature, but for the accommodation of communities and individuals.

Curves are calculated with even radii and odd deflections. A curve is not known by the number of degrees subtended by a unit of measure on the curve, but by the number of 100 metres in the radius, 100 metres being the usual maximum.

In grades, no equation is made for curvature, yet the Englishmen express surprise that "the engine can't round a 90 metre curve on the maximum grade."

After the location, the construction engineer comes along and digs a trench or plows a furrow along the center line, setting a good large stake at the end of each kilometre. This constitutes, or corresponds to, the slope-staking. Estimates are probably made from slopes taken for contour maps. Very rarely (only on sharp curves and high dumps) does the engineer test the completeness of the work by an application of his instruments. The American contractor remarks: "If my borrow pit looks neat, I have no fear of my work being rejected." No temporary bridges are put in, as is done in many parts of the United States. All bridges are of iron or stone, and must precede the tracklaying.

To a Western Yankee, the Britisher presents the appearance, not only of being behind the times in railroad work, but also of beginning at the wrong end. For instance, the Mexican railway, instead of being pushed rapidly from the source of supplies on the coast, was begun at both ends at the same time, the Mexican end requiring all the material (12,000 to 15,000 tons) to be transported with mules an average distance of 200 miles over a summit of 8,000 ft. altitude. It is not then surprising that 36 years and $123,000 per mile were consumed in building this road.

Again, the Interoceanic (described in Wellington's work on Railway Location) a portion of which was designed to parallel the Mexican Railway from Vera Cruz to the City of Mexico, was begun, not at Vera Cruz, but at Mexico and Pueblo, more than 200 miles from the source of material, thus affording an excellent opportunity to pay enormous freights to a rival company. No wonder that the thing hangs fire after thirteen years of struggle.

A third instance is the Mexican Southern, now building designed to connect Pueblo with the Pacific coast at Tehuantepec. Like the Interoceanic, it pays tribute to the Mexican on material from the coast.

Tracklaying on the Mexican Southern will begin soon at Pueblo; 75 or 100 kilometers are already graded. For the first 200 kilometers south from Peublo the line was through a rich and populous country with easy grades and light work. Further south the work is supposed to be heavier, though it is nowhere considered difficult.

F. MEREDITH JONES.

[Englishmen have plenty of sins to answer for, no doubt, but they are not responsible for the hauling of rails inland by wagon in order to carry on tracklaying on the original Mexican Railway from both ends of the line simultaneously. The Government insisted on this absurd procedure, despite many protests. On the Interoceanic it may have been done in order to complete early the very easy work on the upper plateau and begin earning money from it. On the Mexican Southern a similar motive may have led to it; in addition to which, hauling the steel by rail up from Vera Cruz saved carrying it by sea around Cape Horn.—ED. ENG. NEWS.]

A Peculiar Wreck.

NORWALK, O., Oct. 4, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

I send you herewith a clipping from our city paper, which will almost explain itself, but I will add a few further details:

A fatal and peculiar wreck occurred in the W. & L. E. cut under West Main St. last (Friday) night, a few minutes before 11 o'clock, whereby brakeman McSWEENEY lost his life, and seven cars were more or less demolished.

A freight train was leaving the yards bound south, and when passing under the West Main St. bridge McSWEENEY, who was standing on one of the cars, was knocked down by striking against the bridge, and fell between the cars. The wheels, in passing over him, threw the cars off the track, and they were strewn along the track from the bridge to the depot, tearing up about 50 ft. of the depot platform.

McSWEENEY's head was jammed in, and one of his legs torn into fragments. He died instantly.

This West Main St. Bridge has been the means of a good deal of trouble to the city, as only last spring a suit compelling the company to construct a suitable stone bridge at that point was withdrawn when it was promised to construct the bridge within three years. The present bridge is piles planked up, nearly ready to fall down, and in fact a rather dangerous construction. The W. & L. E. Ry. come into this yard from the west, parallel with the Lake Shore Ry., but when they leave their yard at the east end, the line makes a sharp curve about 40 rods north of Main St. Bridge so as to cross at nearly right angles. From the bridge it takes another sharp curve to the east. The depot is an old rookery, situated some 60 rods east on this tangent at the crossing of Benedict Ave. Neither of these curves has any guard-rails, nor have the approaches to the bridge any overhead guards, to warn green train-men. The bridge is just high enough to clear a locomotive smoke-stack; as you will see from this description, it is a dangerous place.

The facts in this case seem to be that the cars struck the platform and piled up in a wreck, throwing some cars down the bank into Norwalk Creek, and others across the track. Had they continued ten feet farther, the baggage room would have gone down the bank, and the baggage master have been killed or seriously injured. This train had a pusher on the rear end, as they have a very stiff grade east of city for about three miles, and this had something to do with the accident. In my two years

residence near this point, there have been no less than seven wrecks on this curve. Only a few months ago an engine was knocked off the track by running into the rear end of a yard train.

Yours truly,

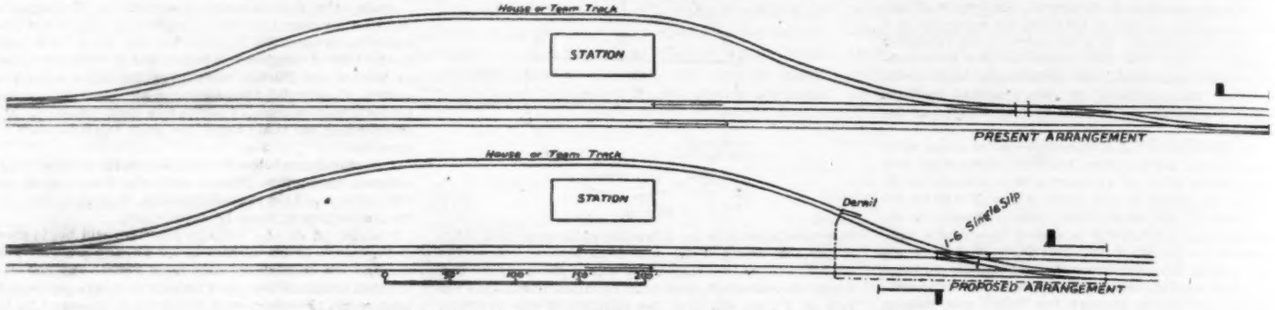
N.

The Elimination of Facing-Point Switches.

CHICAGO, Ill., Nov. 1, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

I enclose a tracing of a proposed plan for partially getting rid of facing-point switches in double-track lines, and I wish to know whether this method has been used by any railway, and if it has been used, whether successfully or not. My idea is to use this connection at stations of minor importance where there is only a house or team track, which is too short or is for other reasons never used as a passing track. The object of the one-sixth single slip instead of a plain crossing is to allow trains on either main track to back across to the other main, when required to get out of the way of a train running in the same direction.



Plan for Eliminating Facing-Point Switches on Double-Track Lines.

Yours truly,

X. P. T.

[The plan is new, to us at least, and seems to us a good one for the purpose and in the localities tated. Perhaps some of our readers can give further information on the subject, however.—ED. ENG. NEWS.]

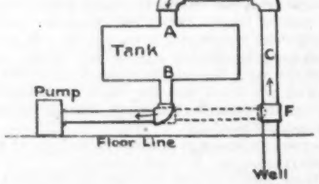
A Hydraulic Conundrum.

PHILADELPHIA, Pa., Oct. 29, 1889.

TO THE EDITOR OF ENGINEERING NEWS:—

Will you help me out in the following hydraulic conundrum?

A 3-in. tube well is connected to a cylindrical tank at *A*; from its bottom at *B* goes a 2 in. pipe to the pump. The turn of the pipe before entering the tank is thought to make a syphon by means of which it should be easier on part of the pump to raise the water.



It seems to me as though there were no room for the syphon principle in this arrangement, because the water level in the ground is 16 ft. below *A*. Is it not questionable whether a sufficient vacuum can be created in a suction pipe of such a shape, part of it being at a higher elevation than the pump? The tank can hardly be considered as anything but a larger section of the suction pipe, as far as I understand, and the proper way to connect the well to the pump is doubtless to run a pipe horizontally from *f* to the pump.

Yours very truly,

ANDREW FLEMSTROM.

[Our correspondent is generally correct in his views There can certainly be no syphon action towards the pump; and the tank as a reservoir to the pump will have no practical value, because if it does assist in insuring a full water cylinder at each stroke, an equal quantity of water must be lifted in the pipe *C*; otherwise the tank would empty in time. The best location for the pump would be directly over the pipe *C*. Or, if that is impossible, then connect by a bend of considerable radius rather than by an "L" connection.—ED. ENG. NEWS.]

Cost of Pneumatic Foundations.

One of the best features of Prof. I. O. BAKER'S admirable "Treatise on Masonry Construction," which was reviewed in our issue of Oct. 26, is the full details which it gives as to cost of various kinds of masonry and foundation work. The subjoined information as to the cost of pneumatic foundations is an excellent sample of the way in which this kind of information is presented, and as a particularly valuable condensed analysis of information which it is somewhat difficult to obtain, we reprint it, by permission of the author.

The contract for pneumatic foundation is usually let at specified prices per unit for the materials left permanently in the structure and for the material excavated, including the necessary labor and tools. The prices for material in place are about as follows: Timber in caisson proper, from $10 to $50 per M. ft. B. M., according to the locality in which the work is done; and the timber in the crib-work and coffer-dam about $5 to $7 per M. less. The concrete,[1] which is usually composed of broken stone and sufficient 1 to 2 or 1 to 3 Portland cement mortar to completely fill the voids, costs, exclusive of the cement, from $5 to $7 per cu. yd., for that in the crib, and about twice this sum for that in the air-chamber and under the cutting edge. The wrought-iron spikes, drift-bolts, screw-bolts, and cast-iron washers cost from 3½ to 6 cts. per lb.[1] The caisson and filling costs from $14 to $20 per cu. yd.; and the crib and filling from $8 to $10.

The price for sinking, including labor, tools, machinery, etc., ranges, according to the kind of soil, from 18 to 40, or even 50 cts. per cu. ft., of the volume found by multiplying the area of the caisson at the cutting edge by the final depth of the latter below low water. In sand or silt the cost is 18 to 20 cts., and in stiff clay and boulders 40 to 50 cts.

TABLE 32.

COST TO THE RAILWAY COMPANY OF THE PNEUMATIC FOUNDATIONS OF HAVRE DE GRACE BRIDGE.*

ITEMS.	Number of the Pier.				
	II.	III.	IV.	VIII.	IX.
Depth cutting edge below low water, feet	68.3	70.7	59.9	76.0	65.0
Depth of cutting edge below mud line, feet	55.5	58.7	32.3	55.2	32.6
Displacement below low water, cu. ft	112,124	123,402	159,588	189,578	231 691
" " mud line, cu. ft	94,504	106,269	84,014	127,586	107,836
Caisson: timber, @ $46 80 per M	$9,522 54	$10,088.44	$14,820.94	$13,176.07	$21,767.85
iron, @ 5¼ cts. per lb	1,456.12	1,587.15	2,596.23	2,242.40	3,295.38
concrete, @ $17.50 per cu. yd	5,775 00	7,017.50	13,247.50	18,987.50	25,60?.50
total cost, per net cu. yd	16.82	18.37	19.19	24 34	22.10
Crib: timber, @ $46 80 per M	8,421.14	9,?62.19	6,738.87	8,936.58	9,538.96
iron, @ 5¼ cts. per lb	1 291.14	1,454 85	1,179.34	1,749.35	1,445.93
concrete, @ $8.50 per net cu. yd	14,016 50	16,?60.50	13,897.50	21,943.50	26,962.00
total cost, per cu. yd	10.76	11.10	10.91	9.91	10.60
Cofferdam: timber, @46.80 per M	96 78	1,375 00	5,078.54	4,013.52	5,621.70
iron, @ 5¼ cts. per lb	14.45	236.15	802.29	684.20	899.22
Cost of sinking, @ 20 cts. per cu. ft. of displacement below low water	22,424 80	24,680.40	31,917.60	37,915.60	46,338.20
Concrete below cutting edge, @ $17.50	000	10,902.50	2,205.00	9,205 00	10,920.00
Total cost of foundation	63,018.47	71,792.18	90,368.93	109,648.72	141,772.44
Total cost per cu. yd. of foundation below masonry, including coffer-dams	19.93	21.58	25 20	23.30	23.44

Average total cost of foundation to railway company, per net cubic yard. $22.69.

*Data by courtesy of Sooysmith & Co., contracting engineers for the pneumatic foundations.

TABLE 33.

COST OF PNEUMATIC FOUNDATIONS OF BLAIR BRIDGE.*

ITEMS.	Number of the pier.			
	I.	II.	III.	IV.
Total distance caisson was lowered after completion	55.6 ft.	54 5 ft.	56 2 ft.	68 5 ft.
Final depth of cutting edge below surface of water	51.9 "	52 3 "	53 4 "	57.0 "
" " " " " mud line	47.7 "	51.0 "	49.4 "	54.7 "
Caisson and filling, cost of	$ 11,753.51	$ 12,386 56	$ 13,819 34	$ 11,252.45
" " " per cubic yard	14.31	15,12	16.74	lo 77
Crib and filling, cost of	7,368.16	.....	.....	6,303.46
" " per cubic yard	8.85	.....	.....	7.59
Air-locks, shafts, etc., cost of	1.481 60	1 567.42	1,536 80	1,521 48
Sinking caisson cost of, including erection and removal of machinery	5,772.52	5,629.37	6,888.16	7,084.26
Sinking caisson, cost of, per cubic foot of displacement below position of cutting edge when caisson was completed	8.0 cts.	8 0 cts.	9,5 cts.	7.1 cts.
Sinking caisson, cost of per cubic foot of displacement below surface of water	8.6 "	8.3 "	9 9 "	9.6 "
Sinking caisson, cost of, per cubic foot of displacement below mud line	9,3 "	8.5 "	10,8 "	10,0 "
Total cost † of foundation	$ 26,375.79	$ 19,583 35	$ 22,244.30	$ 26,161 25
" " " per cubic yard	15,98	23.87	27.08	15,85

Average cost † of the foundations, per cubic yard $20,70.

*Compiled from the report of GEO. S. MORISON, chief engineer of the bridge.

†Exclusive of engineering expenses and cost of tools, machinery, and buildings In a note to the author, Mr. MORISON, the engineer of the bridge says: "It is impossible to divide the buildings, tools, and engineering expenses between the sub-structure and other portions of the work. The bulk of the items of tools and machinery [$12,389.88], however, relates to the foundations." The engineering expenses and buildings were nearly 3 per cent. of the total cost of the entire bridge. The cost of tools and machinery was equal to a little over 13 per cent. of the foundations as above. Including these items would add nearly one-sixth to the amounts in the last three lines.

Table 32 gives the details of the cost of the pneumatic foundation of the Havre de Grace bridge, as fully described in §§ 438–444.

Table 33 gives the details of the cost of the pneumatic caissons of the bridge across the Missouri River near Blair, Neb. The caissons (Fig. 65, page 285) were 54 ft. long

[1] There are usually from 140 to 150 lbs. of iron per M. ft. B. M. of timber.

24 ft. wide, and 17 ft. high. In the two shore piers, Nos. I and IV of the table, the caissons were surmounted by cribs 20 ft. high; but in the channel piers, the masonry rested directly upon the roof of the caisson. The work was done, in 1882-83, by the bridge company's men under the direction of the engineer.

In 1869-72, thirteen cylinders were sunk by the plenum-pneumatic process for the piers of a bridge over the Schuylkill River at South St., Philadelphia. There were three piers, one of which was a pivot pier. There were two cylinders, 8 ft. in diameter and 82 ft. long, sunk through 22 ft. of water and 30 ft. of "sand and tough, compact mud intermingled with boulders;" two cylinders, 8 ft. in diameter and 57 ft. long, sunk through 22 ft. of water and 5 ft. of soil as above; one cylinder, 6 ft. in diameter and 64 ft. long, sunk through 22 ft. of water and 18 ft. of soil as above; and 8 columns, 4 ft. in diameter and aggregating 507 ft., sunk through 22 ft. of water and 18 ft. of soil as above. A 10-ft. section of the 8-ft. cylinders weighed 14,600 lbs., of the 6-ft., 10,800 lbs., and of the 4-ft., 6,800 lbs. The cylinders rested upon bed-rock, and were bolted to it. The actual cost to the contractor, exclusive of tools and machinery, was as in Table 34.

"Considering next the cost of piers of masonry on wrought-iron caissons of excavation, the foundations of the Lorient viaduct over the Scorff cost the large sum of $24.11 per cu. yd, owing to the difficulties caused by the tides, the labor of removing the boulders from underneath the caisson, and the large cost of plant for only two piers. The foundation of the Kehl bridge cost still more, about $28.23 per cu. yd.; but this cannot be regarded as a fair instance, being the first attempt of the kind.

"The foundations of the Nantes bridge, sunk 56 ft. below low-water level, cost about $14.84 per cu. yd. The average cost per pier was as follows:

Caisson (41 ft. 4 ins. by 14 ft. 5 ins.) 50 tons of wrought iron @ $116.88	$5,844
Coffer dam, 3 tons of wrought iron @ $58.44	175
Excavation, 916 cu yds. @ $4.47	4 091
Concrete	4,188
Masonry, plant, etc.	1,870
Average cost per pier	$16,168

"One pier of the bridge over the Meuse at Rotterdam with a caisson of 222 tons and a coffer-dam casing of 94 tons and sunk 75 ft. below high water, cost $70,858, or $13.97 per cu. yd.

TABLE 34.

COST OF PNEUMATIC PILES AT PHILADELPHIA IN 1869-'872.*

ITEMS OF EXPENSE.	Diameter of cylinders. 4-ft.	6 ft.	8-ft.
Cost of cast-iron, @ $59.50 per ton	$11,239.36	$2,053.75	$13,577 90
" " bolts, @ 9¾ cts. per lb	489.84	93.31	670.02
" "grouted rubble masonry (exclusive of labor), @ $5.40 per cu. yd	1,260.79	358.40	2,779.97
" " sinking and laying masonry	6,699.50	911.88	9,036.51
Total cost of the cylinders in place	$19,689.49	$3,417.34	$26,064.40
Cost of iron per lineal foot of cylinder	$23.10	$33.54	$51.25
" " materials for masonry per lineal foot of cylinder	2.50	5.60	10.00
" " sinking and laying masonry per lineal foot of cylinder	13.20	14.25	32.51
Total cost, † per lineal foot of cylinder in place	$38.80	$53.39	$93.76

*Compiled from an article by D. McN. STAUFFER, Engineer in Charge, in Trans. Am. Soc. of C. E., vol. vii, pp. 287-309.

†Exclusive of tools and machinery.

"Excavation in the Brooklyn caisson [1] cost for labor only, including the men on top, about $5.25 per cu. yd. [19 cts. per cu. ft.] Running the six air-compressors added to this $3.60 per hour, or about 47 cts. per yd; lights added $0.56 more; and these with other contingencies nearly equaled the cost of labor. The great cost was due to the excessive hardness of the material over much of the surface, the caisson finally resting, for nearly its whole extent, on a mass of boulders or hard-pan. The concrete in the caisson cost, for every expense, about $15.50 per cu. yd. The caisson and filling together aggregated 16,808 cu. yds; and the approximate cost per yard for every expense was $20.71." [2] The foundation therefore cost about $30 per cu. yd.

The pneumatic foundations for the channel piers of the bridge over the Missouri at Plattsmouth, Neb., cost as follows: One foundation, consisting of a caisson 50 ft. long, 20 ft. wide, and 15.5 ft. high, surmounted by a crib 14.15 ft. high, sunk through 13 ft. of water and 20 ft of soil, cost $19.29 per cu. yd. of net volume. Another, consisting of a caisson 50 ft. long, 20 ft. wide, and 15.5 ft. high, surmounted by a crib 36.25 ft. high, sunk through 10 ft. of water and 44 ft. of soil, cost $14.45 per cu. yd. of net volume.[3]

European Examples.—The following [4] is interesting as showing the cost of pneumatic work in Europe:

"At Moulins, cast-iron cylinders, 8 ft. 2½ ins. in diameter, with a filling of concrete and sunk 33 ft. below water into marl, cost $62.94 per lin. ft., or $29.71 for the iron work, and $33.23 for sinking and concrete. At Argenteuil, with cylinders 11 ft. 10 ins. in diameter, the sinking alone cost $42.12 per lin. ft. [nearly $10 per cu. yd.], where a cylinder was sunk 53½ ft. in 390 hours. [The total cost of this foundation was $34.09 per cu. yd. At Orival, where a cylinder was sunk 49 ft. in 20 days, the cost of sinking was $36.83 per lin. ft. At Bordeaux, with the same sized cylinders, a gang of eight men conducted the sinking of one cylinder, and usually 34 cu. yds. were excavated every 24 hours. The greatest depth reached was 55¾ ft. below the ground, and 71 ft. below high water. In the regular course of working, a cylinder was sunk in from 9 to 15 days, and the whole operation, including preparations and filling with concrete, occupied on the average 25 days. One cylinder, or a half pier, cost on the average $11,206.40, of which $1,461 was for sinking. M. MORANDIERE estimates the total cost of a cylinder sunk like those at Argenteuil, to a depth of 50 ft., at $7,012 80.

"The Vichy bridge has five piers built on caissons 34 ft. by 13 ft., and two abutments on caissons 26 ft. by 24 ft. The foundations were sunk 23 ft. in the ground, the upper portion consisting of shingle and conglomerated gravel, and the last 10 ft. of marl. The cost of the bridge was as follows:

Interest for eight months, and depreciation of plant worth $9,480	$3,896
Cost of preparations, approach bridge, and staging	4,904
Caissons (seven), 150¾ tons @ $113.38	17,108
Sinking	9,823
Concrete and masonry	5,306
Contractor's bonus and general expenses	6,107
Total cost of five foundations	$47,141

The cost per cubic yard of the foundation below low water was $16.69, of which the sinking alone cost $3.50 in gravel, and $4.37 in marl.

"At St. Maurice, the cost per cubic yard of foundation was $15.94, exclusive of staging."

Conclusion.—Except in very shallow or very deep water, the compressed-air process has almost entirely superseded all others. The following are some of the advantages of this method. 1. It is reliable, since there is no danger of the caissons being stopped, before reaching the desired depth, by sunken logs, boulders, etc., or by excessive friction, as in dredging through tubes or shafts in cribs. 2. It can be used regardless of the kind of soil overlying the rock or ultimate foundation. 3. It is comparatively rapid, since the sinking of the caisson and the building up of the pier go on at the same time. 4. It is comparatively economical, since the weight added in sinking is a part of the foundation and is permanent, and the removal of the material by blowing out or by pumping is as uniform and rapid at one depth as at another,—the cost only being increased somewhat by the greater depth. 5. This method allows ample opportunity to examine the ultimate foundation, to level the bottom, and to remove any disintegrated rock. 6. Since the rock can be laid bare and be thoroughly washed, the concrete can be commenced upon a perfectly clean surface: and hence there need be no question as to the stability of the foundation.

[1] For a brief description, see § 458.

[2] F. COLLINGWOOD, Assistant Engineer Brooklyn Bridge, in Trans. Am. Soc. of C. E.

[3] Compiled from the report of GEO. S. MORISON, Chief Engineer of the bridge.

[4] By JULES GAUDARD, as translated from the French by L. F. VERNON-HARCOURT for the Proceedings of the Institute of Civil Engineers (London).

Asphalt Pavements on Concrete Foundations in New York.

The following is an abstract from the latest specification for laying asphalt pavement on a concrete foundation in the city of New York:

THE BRIDGE STONES are to be bluestone equal to best quality of North River bluestone; each stone to be not less than 4 nor more than 8 ft. long and 2 ft. wide; of a uniform thickness varying from 6 to 8 ins., and dressed to a face on top not varying in evenness by more than ¼-in. They are to be laid to a joint not exceeding ¼-in. from top to bottom on ends and ½-in. on sides.

7. PREPARATION OF ROADBED, ETC.—All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the trap and granite blocks to be deposited where directed by the Water Purveyor for the use of the city; the subsoil or other matter (be it earth, rock, or other material) shall then be excavated and removed by the contractor to the depth of 8½ ins. below the top line of the proposed pavement. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material should be removed, and the space filled with clean gravel or sand carefully rammed, so as to make such filling compact and solid, and the entire roadbed thoroughly rolled with a heavy roller. Should any filling be necessary to lay the pavement at the required grade, the contractor shall supply the same without any extra compensation therefor; said filling to be composed of good, wholesome earth, free from ashes, garbage or other foreign matter, and placed upon the roadbed, thoroughly rammed or rolled, as the Commissioner shall direct, at any point, in layers of not more than 6 ins. in depth, thoroughly compacted. Upon the foundation thus prepared shall be laid a bed of hydraulic cement concrete, 6 ins. in thickness, to be made as follows:

One part of American cement, equal to the best quality of freshly burned Rosendale cement, two parts of clean, sharp, washed sand, free from clay, to be thoroughly mixed dry and then made into a mortar with the least possible amount of water; to this shall be added three parts of sound stone, broken with a hammer, the largest of which will pass through a 2-in. ring, the said broken stone to be wet before being added to the mortar. The whole mass shall then be shoveled over until it is thoroughly mixed before it is put in place; it shall then be put in place and rammed until it is thoroughly compacted and has a clean mortar surface.

The whole operation of mixing and laying such batch will be performed as expeditiously as possible, by the employment of a sufficient number of skilled men. The upper surface will be made exactly parallel with the pavement when laid, and, if necessary, will be protected from the action of the sun and wind until set. No concrete will be allowed to be used which has been mixed more than three hours.

Upon this foundation shall be laid the wearing surface, or paving proper, the basis of which or paving cement will be pure asphaltum unmixed with any of the products of coal-tar.

The wearing surface shall be composed of: (1) Refined asphaltum. (2) Heavy petroleum oil. (3) Fine sand, containing not more than one per cent. of hydro-silicate of alumina. (4) Fine powder of carbonate of lime.

The asphaltum shall be specially refined and brought to uniform standard of purity and gravity of a quality to be approved by the Commissioner of Public Works. The heavy petroleum oil shall be freed from all impurities and brought to a specific gravity of from 18 to 22° Beaumè, and a fire-test of 250° Fahr. From these two hydro-carbons shall be manufactured an asphaltic cement which shall have a fire-test of 250° Fahr., and at a temperature of 60° Fahr. shall have a specific gravity of 1.19, said cement to be composed of 100 parts of pure asphalt and from 15 to 20 parts of heavy petroleum oil.

The asphaltic cement being made in the manner above described, the pavement mixture will be formed of the following materials, and in the proportions stated:

Asphaltic cement	from 12 to 15
Sand	from 83 to 70
Pulverized carbonate of lime	from 5 to 15

The sand and asphaltic cement are to be heated separately to about 300° Fahr. The pulverized carbonate of lime, while cold, shall be mixed with the hot sand in the required proportions, and then mixed with the asphaltic cement at the required temperature, and in the proper proportion, in a suitable apparatus, which will effect a perfect mixture.

The pavement mixture prepared in the manner thus indicated shall be laid on the foundation in two coats. The first coat, called cushion coat, shall contain from 2 to 4 per cent. more asphaltic cement than given above; it will be laid to such depth as will give a thickness of ½ in. after being consolidated by a roller. The second coat, called surface coat, prepared as above specified, shall be laid on the cushion coat; it shall be brought to the ground in carts, at a temperature of about 250° Fahr., and if the temperature of the air is less than 50°, iron carts, with heating apparatus, shall be used in order to maintain the proper temperature of the mixture; it shall then be carefully spread by means of hot iron rakes, in such manner as to give a uniform and regular grade, and to such depth that after having received its ultimate compression, it will have a thickness of 2 ins. The surface shall then be compressed by hand rollers, after which a small amount of hydraulic cement shall be swept over it, and it shall then be thoroughly compressed by a steam roller weighing not less than 250 lbs. to the inch run; the rolling to be continued for not less than five hours for every 1,000 yds. of surface.

The powered carbonate of lime shall be of such degree of fineness that 5 to 15 per cent. by weight of the entire mixture for the pavement shall be of an impalpable powder of limestone, and the whole of it shall pass a No. 26

screen. The sand shall be of such size that none of it will pass a No. 80 screen, and the whole of it shall pass a No. 10 screen.

In order to make the gutters, which are consolidated but little by traffic, entirely impervious to water, a width of 12 ins. next the curb will be coated with hot pure asphalt and smoothed with hot smoothing irons in order to saturate the pavement to a certain depth with an excess of asphalt.

8. LAYING THE CROSSWALKS, ETC.—The crosswalks adjoining the new pavement are to be laid, or the present bridge-stones shall be relaid, as the said Commissioner of Public Works may direct, in which last case they shall be dressed or re-dressed so as to form ¼ in. joints from top to bottom when laid. All the new bridge-stones, and such of the present bridge-stones as may be retained, are to be well and firmly bedded on a foundation of sand or gravel, not less than 6 ins. in thickness, and laid with joints not exceeding ¼ in. in width from top to bottom on the ends. The courses to be so laid that the traverse joints will be broken by a lap of at least 1 ft. The pavements adjoining, and also the gutters of the adjoining pavements, as far as in the opinion of the said Commissioner may be necessary to obtain proper drainage, will be taken up, brought to the grade of the new pavement and relaid, without extra charge therefor. The contractor shall lay one row of paving blocks between the courses of bridge-stone when directed so to do by the Water Purveyor.

By the terms of this specification the contractor must keep this pavement in repair for five years after completion and acceptance of the work, without further compensation. The penalty for not doing so is that it shall be done, 48 hours after serving notice, at the expense of the contractor, and he stipulates and agrees that he will pay these charges. The work may also be suspended for such periods as the Commissioner of Public Works may deem proper, without founding a claim for damages, by reason of such suspension, from the contractor. The contractor also agrees to lay the pavement at the contract price, over trenches made for water or gas pipes, sewers, etc.; and to demand no additional sum on account of sinking of pavement so laid, and to maintain this portion of the pavement on the same terms as the rest of it.

For laying the asphalt pavement on existing macadam pavement, the specifications provide that the surface of the macadam is to be thoroughly swept with stiff brooms, and the surface brought to a uniform grade and cross-section. All depressions are to be filled with a fine bituminous concrete or binder, to be composed of clean broken stone not exceeding 1½ in. in largest dimension, thoroughly screened, and coal tar residuum, commonly known as No. 4 paving composition. The stone to be heated by passing through revolving heaters and thoroughly mixed by machinery with the paving composition in the proportion of 1 gall. of the composition to 1 cu. ft. of stone. The binder shall be hauled to the work and spread with hot iron rakes in all holes, irregularities, and depressions below the true grade of the pavement, to such thickness that after being compacted by tamping and hand rolling, the surface shall have a uniform grade and cross-section, and the thickness at any point shall not be less than 1 in. In no case shall the thickness be more than 2½ ins. In case greater thickness is required to bring the pavement to the required grade, it is to be obtained by laying upon the macadam pavement a base course of sufficient thickness of broken stone, not exceeding 1½ ins. in size, which shall be rolled and rammed and then treated with not less than 1 gall. of the hot coal tar residuum (No. 4) to the square yard. Upon this base course will be laid the binder course. The asphalt wearing surface is to be similar to that described in the foregoing specifications for asphalt pavement on concrete foundation.

For laying the asphalt pavement on existing stone block pavement, the surface of the pavement must be thoroughly swept with stiff brooms until all dirt and fine particles have been removed from the surface and from the joints to a depth of 2 ins. The surface must then be brought to a uniform grade, and cross-section, not to exceed a crown of 5 ins. on a roadway 30 ft. wide, by filling in with the same bituminous concrete specified for covering the macadam pavement, the thickness of this binder not to be less than ¾-in. The wearing surface shall be of asphalt as already specified.

Railway Embankments and Land Drainage.

The *Daily Press*, of Hong Kong, China, recently gave the following interesting note:

A curious and quite unexpected result of railway construction in India has recently been brought to light. The Sanitary Commissioner for Bengal, Dr. GREGG, struck by the terrible mortality from malarial fever in his province, and by the steadily increasing number of deaths from this cause year by year, sought to grapple with the problem. His conclusion practically amounts to this: That the roads, bunds, and embankments that form a network over Bengal are simply water-logging an already imperfectly drained country. It will be very many years before China is covered with a network of railways; but as the work is being entered on, the engineers may advantageously profit by the experience of India, and take care that their embankments are not allowed to obstruct the natural drainage. In many cases it would no doubt be possible even to take advantage of the railway works to improve the drainage, and so render malarious districts healthy.

The construction of railways in India, it would seem, owing to their effect on the drainage having been overlooked, has unfortunately had the result of intensifying the malarious character of certain districts. This, however, is capable of remedy by the provision of numerous culverts with drains of proper slope leading to them. The point is one which should receive the attention of the constructors of railways in China, so that while with one hand conferring on the country the advantages of improved communication, they may not with the other unconsciously cultivate the germs of a deadly disease.

THE PROPOSED BRIDGE at Omaha, over the Missouri River, is favored by the *World-Herald* of that city; and the citizens of Omaha are advised to vote for the $250,000 subsidy which the company asks. At the same time the journal advises voters to oppose the $150,000 grant toward the construction of the Union Depot and viaduct, on the ground that the latter will be built in any case, whether the city votes aid or not.

A MILL DAM at Alton, Ont., gave way NOV. 13, and the flood carried away six mill dams and four bridges, including the Canadian Pacific Railway Bridge, and did much damage to buildings and other property.

A Manual of Railway Field Work and Laying Out of Works.

ACCORDING TO THE MOST RECENT AND APPROVED PRACTICE ON AMERICAN RAILWAYS.

BY A. M. WELLINGTON,
M.Am.Soc.C.E., M.Inst.C.E., etc.

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[*Continued from p. 451.*]

[The author will be pleased to receive typographical or other corrections, or suggestions as to form or substance, from any interested reader. All such suggestions will have full consideration.]

Chapter II. THEORETICAL PRELIMINARIES (continued).

Among English engineers curves are usually defined as of so many chains (66 ft.) radius. The radius of a 1° curve in chains is $\frac{5729.65}{66} = 86.813$ chains, so that the one method of designation may be converted into the other by the formulas

$$R \text{ in chains} = \frac{86.813}{D}, \text{ and } D = \frac{86.813}{R \text{ in chains}} \quad \ldots\ldots (\ )$$

Continental engineers designate curves by the radius in metres. The radius in metres of a 1° curve being $\frac{5729.65}{3.2804} = 1746.4$ metres, we have, for converting the one method of designation into the other, the similar formulas

$$R \text{ in metres} = \frac{1746.4}{D}, \text{ and } D = \frac{1746.4}{R \text{ in metres}} \quad \ldots\ldots (\ )$$

American engineers, and those adopting American practice, when working with the metric system, use, as the unit chord, a chain of 20 metres (65.61 ft.) divided into 100 links of 2 decimetres (.656 ft.) each. The radius of a curve having 1° of central angle for a chord of 100 of any unit is 5730 (5729.65) of that unit, so that the radius in metres of a 1° metric curve is 5729.65 × 0.2 = 1145.93 (1146) metres, or one-fifth as many metres as there are feet in the radius of a 1° foot curve—as is natural from the fact that there are only one-fifth as many units in the chord.

It is, therefore, entirely unnecessary to have separate tables of radii and angular functions for running curves by metric or any other measures. If the unit chord of whatever length be divided into 100 units, the radius of a 1° curve will be 5,730 of those units. There being only 20 instead of 100 units in the 20-metre chain usual for metric field-work, the radius of a metric 1° curve will be $5{,}730 \times 0.2 \left(\frac{20}{100}\right) = 1{,}146$ metres, and similarly for all other radii and all other curve functions. In other words:

MULTIPLYING THE RADII AND OTHER CURVE FUNCTIONS COMPUTED FOR FEET BY 0.2 GIVES THE CORRESPONDING METRIC VALUES FOR THE SAME FUNCTIONS WHEN THE UNIT OF MEASUREMENT IS A 20-METRE CHAIN. If the unit of measurement were 10 metres, they could be used unchanged by simply moving the decimal point. This is so little trouble as to make separate metric tables quite needless.

In stationing under the metric system, however, the best practice is to use 10-metre stations, setting stakes at every other station only (or 1 chain apart) on tangents and easy curves, and at every station (or half-chain) on sharp curves. In practice this produces little inconvenience, the stakes being marked 2, 4, 6, 8, etc., instead of 1, 2, 3, 4, etc.

The radius in feet of a 1° metric curve is $\frac{65.61}{100}$ of the radius of a 1° "foot" curve, or a little (1½ per cent.) less than ⅔ (.667) and a little (4.6 per cent.) more than ⅝ (62.5), either of which vulgar fractions may be used for approximate inter-conversions.

With metric as with English measures, it destroys the equality of ratio between Radius and Degree to use the full length of the chain as a chord for sharper than 8° curves. Metric curves of 8° or more are therefore run in with half-chain (10-metre) chords or less; curves of 16° or more are run in with 5-metre chords or less; and curves of 32° or more with 2-metre chords or less, thus corresponding precisely with the ordinary foot-curve practice.

Table . . . gives the radii in feet, chains, and metres of all the curves below 30°, which are much used for either metric or English measures.

It will be apparent from what has preceded that in

Fig. 13.

any arc whatever of which the central angle $O = 1°$, Fig. 13:

THE DISTANCE $R = 57.3$ TIMES THE CHORD $C = \frac{1}{2 \sin ½°} = ½ \operatorname{cosec} ½° = 57.2965$, and

THE CHORD $C = .01745$ TIMES THE DISTANCE $R = \frac{1}{57.3}$

The two proportions of 57.3 and .01745 should be memorized, which is easily done by establishing an analogy with the radius 5730 of a 1° curve, and with the following, which should also be memorized:

TWO LINES AT AN ANGLE OF 1° WITH EACH OTHER SEPARATE FROM EACH OTHER AT THE RATE OF 1.75 (1.745) FT. PER STATION, AND TWO LINES AT AN ANGLE OF 1' AT THE RATE OF 0.03 FT. PER STATION, NEARLY.

Since the sines, tangents, chords and arcs of very small angles are proportional to the angles themselves, we have likewise from these formulas:

sin	1° = .01745	nearly (actually	.0174524)
tan	1° =	" ("	.0174551)
chord	1° =	" ("	.0174530)

And any one of these functions will vary very nearly as the central angle for several degrees. For 10° and 20°, illustrating the extreme limits for any use of this proposition, we have

sin	10° = .1745	nearly (actually	.173648)
tan	10° = "	" ("	.176327)
chord	10° = "	" ("	.174311)
sin	20° = .3490	" ("	.34202)
tan	20° = "	" ("	.363970)
chord	20° = "	" ("	.34729)

The chord varies least from this proportionate increase, and the tangent most, for geometrical reasons obvious from Fig. 9.

Similarly we have

cot	1° = 57.3	nearly (actually	57.2900)
cosec	1° = "	" ("	57.2987)

and for other angles

cot	$10° = \frac{57.3}{10}$ = 5.73	nearly (actually	5.67128)
cosec	10° = " = "	" ("	5.75877)

Thus by having merely the two constants 57.3 and 1.745 in mind, a considerable range of quick calculations for certain approximate purposes can be made without reference to tables, and if the angles do not exceed 4° or 5° the calculations will usually be sufficiently exact for all actual requirements.

TO DETERMINE THE VALUES OF THE FUNCTIONS OF A 1° CURVE.

In Fig. 14 let $P\ M\ T$ be a circular arc for a given central angle I. Draw the tangents $P\ I$, $I\ T$, chord $P\ T$ and sub-chord $P\ M$. Then we have:

TO DETERMINE THE APEX-DISTANCE $A\text{-}P = P\ I = I\ T$, given radius R and central angle I:

$$tan\ ½\ I = \frac{P\ I}{P\ O} = \frac{T}{R}, \text{ whence}$$

$$T = R\ tan\ ½\ I \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

or for 1° curve

$$A\text{-}P_1 = 5730\ tan\ ½\ I, \text{ approximately} \quad \ldots\ldots\ldots\ldots\ldots (9)$$

or $A\text{-}P_1 = 5729.65\ tan\ ½\ I$, exactly $\ldots\ldots\ldots\ldots\ldots\ldots (10)$

By eq. (9) and not by the more exact eq. (10) Tables 11 and 20 are calculated, for each 10′ of central angle, from which intermediate values can be filled in by the differences given at the side for each single minute.

The less exact equation is preferred because it averages better the trifling fractional error due to the fact that the radii are not precisely proportional to D. Thus, on an arc 60° long of a 1° curve, it gives the Apex-Distance as 3308.2, whereas it is in fact (if 100 ft. chords are used) 3308.0, an error of 0.2 ft. in excess. But for a 60° central angle of a 5° curve, it gives the Apex-Distance as 661.64, whereas it should be 661.80, an error of 0.16 ft. in deficiency. These errors only amount to 0.006 and 0.024 ft. per 100 respectively, which is well within the usual limits of error in practical field-work, even in this rather extreme example, but the maximum possible errors are minimized by using the approximate formula.

Since all the curve functions $P\ I$, $P\ T$, $M\ C$, etc., for a given central angle are proportional to the radius, and since the radius (§) is proportional to the degree of the curve, we have

GIVEN the Apex-Distance for a 1° curve, $P\ V$ or $P\ T$, for a given central angle I, to determine the

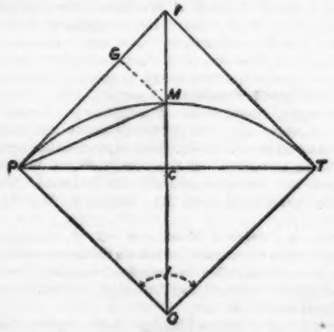

Fig. 14.

Apex-Distance, $A\text{-}D_d$ for a curve of any other D degree with the same central angle:

$$A\text{-}D_d = \frac{A\text{-}D_1}{D} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

CONVERSELY, given the length of the Apex-Distance $A\text{-}D$, and the central angle I, to determine the radius R or degree of curve D:

By the general formula, eq. (8), we have

$$R = \frac{A\text{-}D}{tan\ ½\ I} = T\ cot\ ½\ I. \quad \ldots\ldots\ldots\ldots (12)$$

or, by the aid of a table of natural or logorithmic Apex-Distances (Tables 11 and 20) and eq. (11) we have

$$D = \frac{T_1}{T} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

EXAMPLE: 1. Apex-Distance 630 ft. and central angle 38°, to determine D: By Table 11 $A\text{-}D_1$ for 38° = 1973.0: $\frac{1973.0}{600} = 3.2883° = 3°\ 17.3'$ curve.

2. Same conditions; to modify length of Apex-Distance to give a 3° 20′ curve; $\frac{1973.0}{3⅓} = 197.3 \times 3 = 591.9$.

The same computations may be made by logarithms, taking logs. of $A\text{-}D_1$ from Table 20, and logs. of D from Table 19.

TO DETERMINE THE LONG CHORD $L\text{-}C$, — $P\text{-}T$ Fig. 14, given radius R and central angle I.

Since the line $O\ I$ bisects $P\ T$ in C, we have

$$sin\ ½\ I = \frac{P\ C}{P\ O} = \frac{C}{R}, \text{ whence}$$

$$L\text{-}C = 2\ R\ sin\ ½\ I, \quad (11)$$

or for a 1° curve, substituting 5729.65 and 5730 respectively for R

$$L\text{-}C_1 = 11{,}459.30\ sin\ ½\ I \text{ exactly, or} \quad (12)$$

$$L\text{-}C_1 = 11460\ sin\ ½\ I, \text{ approximately} \quad (13)$$

By eq. (13) Tables 13 and 22 are calculated, for each 10′ of arc.

GIVEN the chord $L\text{-}C_1$ for a 1° curve, to determine the Long-Chord for any other $D°$ curve.

In like manner as for the Apex-Distance (§) we have

$$L\text{-}C_d = \frac{L\text{-}C}{D} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (14)$$

CONVERSELY, given the Long-Chord $L\text{-}C$ and the central angle I to determine the radius R or degree of curve D.

From eq. (11) we have

$$R = \frac{L\text{-}C}{2\ sin\ ½\ I} \quad \ldots\ldots\ldots\ldots\ldots\ldots (15$$

or, by the aid of a table of Long-Chords (Table 13) and eq. (14) we have

$$D = \frac{L\text{-}C_1}{L\text{-}C} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (16)$$

TO DETERMINE THE MIDDLE-ORDINATE $M\text{-}O = M\ C$, Fig. 14, given radius R and central angle I.

Since the angle $M\ P\ T = ¼\ I$ (§) and the value of $P\text{-}T$ is given by eq. (11), we have:

$$tan\ ¼\ I = \frac{M\ C}{P\ C} = \frac{M\text{-}O}{R\ sin\ ½\ I}, \text{ whence}$$

$$M\text{-}O = R\ sin\ ½\ I\ tan\ ¼\ I \quad \ldots\ldots\ldots\ldots\ldots (17)$$

By this formula, substituting for R its approximate value for a 1° curve as explained in §——, Table 14 is calculated, for each 10′ of arc.

GIVEN the Middle-Ordinate $M\text{-}O_1$ for a 1° curve, to determine the middle ordinate for any other $D°$ curve:

In like manner as for the Apex-Distance (§) we have

$$M\text{-}O_d = \frac{M\text{-}O_1}{D} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (18)$$

CONVERSELY, given the Middle-Ordinate $M\text{-}O$ and the central angle I, to determine the radius R, or degree of Curve D:

By eq. (17) we have

$$R = \frac{M\text{-}O}{sin\ ½\ I\ tan\ ¼\ I} \quad \ldots\ldots\ldots\ldots\ldots (19)$$

or by the aid of of a table of Middle-Ordinates (Table 14) and eq. (18) we have

$$D = \frac{M\text{-}O_1}{M\text{-}O} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (20)$$

TO DETERMINE THE EXTERNAL-SECANT, $E\text{-}S = I\ M$, Fig. 12, given radius R and central angle I.

In the triangle $I\ P\ M$, Fig. 14, we have angle $I\ P\ M = ¼\ I$, $P\ I = T$ — $R\ tan\ ¼\ I$ [eq. (8)] and $I\ M$ — $E\text{-}S$. Hence, remembering that $sin\ P\ M\ I$ — $sin\ P\ M\ C$, since the sine of an angle is equal to the sine of its supplement, and that the sines of the three angles of a triangle are proportionate to the opposite sides, and remembering further that $sin\ P\ M\ C = cos\ M\ P\ C$ — $cos\ ¼\ I$, we have:

$$\frac{sin\ ¼\ I}{cos\ ¼\ I} = \frac{I\ M}{P\ V} = \frac{E\text{-}S}{R\ tan\ ½\ I}, \text{ whence}$$

$$E\text{-}S = \frac{R\ tan\ ½\ I\ sin\ ¼\ I}{cos\ ¼\ I}$$

but as $\frac{sin\ ¼\ I}{cos\ ¼\ I} = tan\ ¼\ I$, we have

$$E\text{-}S = R\ tan\ ¼\ I\ tan\ ½\ I. \quad \ldots\ldots\ldots\ldots (21)$$

By this formula, substituting for R its value for a 1° curve (as explained in §—) Tables 12 and 21, of natural and logarithmic External-Secants are calculated.

GIVEN the External-Secant $E\text{-}S$ for a 1° curve; to determine the External-Secant for any other $D°$ curve. We have as before:

$$E\text{-}S_d = \frac{E\text{-}S_1}{D} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (22)$$

CONVERSELY, given the $E\text{-}S$ and the central angle I, to determine the radius R or degree of curves D. By eq. (21) we have:

$$R = E\text{-}S\ cot\ ½\ I\ cot\ ¼\ I \quad (23)$$

or by the aid of a table of External-Secants (Table 12) we have:

$$D = \frac{E\text{-}S_1}{E\text{-}S} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (24)$$

The following is needed for a special use which will shortly appear:

TO DETERMINE THE DIFFERENCE BETWEEN THE EXTERNAL-SECANT AND THE MIDDLE-ORDINATE OF ANY CURVE. The External-Secant must always be greater than the Middle-Ordinate; for in Fig. 14 draw $G\ M$ perpendicular to $V\ P$. Then since the angle $I\ P M$ — angle $M\ P\ C = ¼\ I$ and the line $P M$ is common, we have triangle $P\ G\ M$ — triangle $P\ M\ C$ and $G\ M$ — $M\ C$. But, since the External-Secant $I\ M$ is the hypothenuse of the right angled triangle $I\ G\ M$ and hence longer than either of the other two sides, we have $I\ M > M\ C$ or $E\text{-}S > M\text{-}O$.

To determine the exact difference of length, we have by eq. (21) and (17)

$$E\ S = R\ tan\ ¼\ I\ tan\ ½\ I$$

$$M\text{-}O = R\ sin\ ½\ I\ tan\ ¼\ I$$

whence

$$E\text{-}S - M\text{-}O = R\ tan\ ¼\ I\ (tan\ ½\ I - sin\ ½\ I). \quad (25)$$

The labor of computing the values of $E\text{-}S$—$M\text{-}O$, however, which we shall have occasion to use, may be saved by direct subtraction of the tabular values of $E\text{-}S$ and $M\text{-}O$.

TO DETERMINE THE LENGTH OF THE CURVE L, given the degree of the curve D and central angle I.

Since the degree of a curve is (§) the central angle due to a chord or chords aggregating 100 ft., the total central angle of any curve must be, regarding L as the length of the curve in stations:

$$I = L\ D, \text{ whence } L = \frac{I}{D}. \quad \ldots\ldots\ldots\ldots\ldots (26)$$

EXAMPLE 1. Central angle I of 40°, if $D = 2°$ we have $L = 20$ stations, if $D = 3°$ we have $L = 13⅓$ stations = 13 + 33 ft.

2. Central angle 26° 35′, $D = 1°\ 30'$ we have $L = \frac{26.582}{1.5}$

$= \frac{53.164}{3} = 17.72$ stations = 17 + 72 ft.

The preceding formula (26) is of constant use, being required for every curve run in, either to determine its length from its central angle, or its central angle from its length. The following is needed only for rare and occasional use, but can best be given here.

TO DETERMINE THE DIFFERENCE D, in the length from the $P.\ C.$ to the $P.\ T$, P to T, Fig. 12, via the curve $P\ M\ T$, and via its two tangents $P\ V$, $V\ T$.

We have directly from Fig. 12,

$$D = 2\ T - L \quad (27)$$

By this formula Table 44 is calculated, to be used in determining the change in length of line caused by substituting one curve for another to connect the same tangents, § —.

We have now determined formulas for computing all the curve functions. The following important proposition applies generally to all of these functions:

GIVEN ANY TWO CURVES OF D AND D' DEGREES, AND A COMMON CENTRAL ANGLE I, TO DETERMINE THE DIFFERENCE IN THE VALUES OF ANY CURVE FUNCTION OF THE TWO CURVES; whether it be Apex-Distance, $A\text{-}D$, Long-Chord, $L\text{-}C$, Middle-Ordinate, $M\text{-}O$, External-Secant, $E\text{-}S$, length of curve L, Radius R, or difference D, GIVEN the tabular values of these functions for a 1° curve.

Since all these functions are proportional to the degree of curvature (§ — and —) we have for any function F, of a $D°$ curve:

$$Fd = \frac{F_1}{D}$$

and similarly for a D' curve

$$Fd' = \frac{F_1}{D'}$$

whence for the difference in the value of any function F for a $D°$ and $D'°$ curve, we have, assuming $D > D'$:

$$Fd - Fd' = \frac{F_1}{D} - \frac{F_1}{D'} \text{ whence}$$

$$Fd - Fd' = \frac{D' - D}{D\ D'} F_1. \quad \ldots\ldots\ldots\ldots\ldots (28)$$

Or, in words: THE DIFFERENCE BETWEEN THE VALUES OF ANY CURVE FUNCTION FOR ANY TWO CURVES OF DIFFERENT RADII, FOR A GIVEN CENTRAL ANGLE I, IS EQUAL TO THE VALUE OF THE CORRESPONDING FUNCTIONS FOR A 1° CURVE, $\times \frac{\text{difference}}{\text{product}}$ OF THE TWO DEGREES OF CURVATURE.

This formula is a very important one and should be indelibly engraven on the memory, especially the two words $\frac{\text{difference}}{\text{product}}$.

EXAMPLE 1. Difference of radius, 3° and 4° curve; $5730 \times \frac{4-3}{4 \times 3} = \frac{5730}{12} = 477.5$. Actually, by Table 31, the difference is 1910.1 — 1432.7 = 477.4; a discrepancy of 0.1 ft. being due to the radii R not being precisely proportional to D, and being of no importance since it is far within the limits of error in ordinary field-work.

2. Difference of radius, 120 and 160 curve; $5730 \times \frac{16-12}{16 \times 12}$

$= 5730 \times \frac{1}{48} = 119.37$. Actually, 477.7 — 358.4 = 119.3 ft.

3. Difference of Apex-Distances, 6° and 7° curve, central angle 35°. $A\text{-}D_1$ by Table 11 = $1806.7 \times \frac{7-6}{7\times 6} = \frac{1806.7}{42} = 43.0$ ft.

Proof: $\frac{1806.7}{6} = 301.1$, $\frac{1806.7}{7} = 258.1$; $301.1 - 258.1 = 43.0$.

4. Difference of Long-Chords, 5° and 5° 20' curve, central angle 43° 10'. $L\text{-}C_1$, by Table 13 = $4215.6 \times \frac{5\frac{1}{3} - 5}{5\frac{1}{3}\times 5} =$

$\frac{4215.6}{80} = 52.7$ ft. Proof: $\frac{4215.6}{5\frac{1}{3}} = 790.4$, $\frac{4215.6}{5} = 843.1$;

$843.1 - 790.4 = 52.7$.

5. Difference of External-Secants, 3° and 3° 5' curve-central angle 75°. $E\text{-}S_1$, by Table 12, $1492.5 \times \frac{3\frac{1}{12} - 3}{3\frac{1}{12}\times 3} =$

$\frac{1492.5}{111} = 13.44$ ft. Proof: $\frac{1492.5}{34} = 497.5$; $\frac{1492.5}{3\frac{1}{12}} = 484.054$;

$497.5 - 484.054 = 13.446$. By logarithms we have:

log $E\text{-}S_1$ for 75° (Table 21)		2.17391
" $D - D$ (= 0° 5') (Table 19)		9.92082
		2.09473
" D (= 3°) (Table 19)	0.47712	
" D (= 3° 5') (Table 19)	0.48902	0.96614
	13.446	1.12859

The use of logarithms for this purpose is only convenient when the values of D are very uneven.

(TO BE CONTINUED.)

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Salisbury & Harvey.—The Albert Railway Company, perating a line of railway from Salisbury to Hopewell and Harvey, N. B. 56 miles, has been reorganized under the above name. CHAS. S. SCOLES, of Hillsboro, N. B., is General Manager.

Indianapolis & Vincennes.—M. W. MANSFIELD, of Indianapolis, Ind., Superintendent, wr tes us that the grading has all been completed on the branch from Gosport to North Bedford, 4¼ miles, and that 1 mile of track has been laid. Work is now in progress on the bridges, and it is expected to have these completed and the line in operation by Jan. 1, 1890. The maximum grade is 1 per cent. and the maximum curve is 6°. The object of the road is to open up large quarries of marble and oolitic lime stone, and it will not do passenger business at present.

Confluence & Oakland.—This road has been opened for traffic from Confluence, Pa., to Manor Lands, Garrett County, Md., 20 miles.

Perry County.—This road, running from New Bloomfield to Duncannon, Pa., 11 miles, has been completed and opened for traffic.

Cooperstown & Charlotte Valley.—Surveys are in progress for the extension from Cooperstown Junction up the valleys of the Charlotte and Schoharie Creeks, crossing the Catskill summit near East Windham, and thence down the valley of the Catskill Creek to the Hudson River. It is stated that the maximum grade by this route will not be over 110 ft. per mile.

Pennsylvania.—This company it is reported will spend $2,113,000 this year in purchasing new ground and erecting buildings in and about Philadelphia. The greater portion of the amount will be expended on the erection of new freight houses, and building new wharves in order to handle freight more speedily.

Ulster & Delaware.—Tracklaying on this road has been completed from Hobart to Bloomville, N. Y., 9 miles, and the road has been graded 13 miles further. EDWARD B. CODWISE, of Kingston, N. Y., is Chief Engineer.

Johnsonburg & Bradford.—Col. A. J. WILCOX has the contract for building this road, which is projected to run from Bradford on the Buffalo, Rochester & Pittsburg R. R. to Johnsonburg, Pa., a distance of 40 miles. Grading has already been commenced. The road will be operated in connection with the Buffalo, Rochester & Pittsburg R. R. when completed. J. M. FLOESCH is Chief Engineer.

Kinderhook & Hudson.—The rails and ties for this road, which is to run from Kinderhook to Hudson, N. Y., 16¼ miles, are on hand and tracklaying will begin this week. E. G. FERRIS, of Hudson, N. Y., is Chief Engineer.

Kimbolton & Mansfield.—Surveys are in progress for this road, which is projected to run from Kimbolton to Mansfield, O. A. J. WARNER, of Marietta, O, is at the head of the enterprise.

Projects and Surveys.

Terre Haute & Mississippi River.—C. M. THOMPSON, of Terre Haute, Ind., Secretary, writes us that this road is projected to run from Terre Haute to Chester, Ill. The road is projected in the interest of the city of Terre Haute and the greater part of the stock of the company has been subscribed by the business men of that city. HERMAN HULMAN, of Terre Haute, is President.

Cincinnati, Bloomington & Chicago.—Incorporated in Indiana to build a railway from a point in Dearborn County northwest through the counties of Brown, Clay, Decatur, Warren and Jasper, a distance of about 300 miles.

Trenton & Atlantic.—The locating surveys for this New Jersey road have been completed. The road is to run from Point Pleasant, N. J., via West Point Pleasant, Burrsville, Lakewood, Francis Mills and Allentown, to Trenton, a distance of about 60 miles. C. C. VERMEULE, of 71 Broadway, New York, is Chief Engineer.

SOUTHERN.—Existing Roads.

Roanoke Southern.—G. W. MASLIN, of Winston, N. C., General Manager, has furnished the following information concerning the extension of this road from Walnut Cove north:

The division from Walnut Cove to Madison, N. C., is to be completed by February 1, 1890. Nearly 25 of the 41 miles between Walnut Cove and Martinsville are graded. About 400 men are now at work on the line. Tracklaying began Nov. 15. The maximum grade is 80 ft. per mile and the maximum curve 10°. Contracts have been let for the iron bridge across the Dan River. Breen & Feely are the contractors and ANDREW ONDERDONK the engineer in charge of construction.

Atlanta & West Point.—The extension of this road from East Point to Atlanta, Ga., 6 miles, has been completed.

Laury, Jackson Lumber Co.—J. C. LAURY, of Laury, Ala., has sent us the following information concerning the railway being built by this company:

The road is to run from Laury to Piedmont, Ala., a distance of 20 miles. The route has been surveyed and about 3 miles of the line graded. Work is now in progress and it is expected to have the road completed by Jan. 1, 1890. The route is through a fine timber and mineral country. P. S. FITZGERALD, of Gadsden, Ala., is chief engineer.

Mobile, Jackson & Kansas City.—The contract for building this Mississippi road has been let and work is to begin in 30 days. The road is to run from Mobile, Ala., to Jackson, Miss., 175 miles.

Louisville & Nashville.—The citizens of Clarksville, Tenn., have agreed to subscribe $50,000 toward the construction of the branch from Clarksville to Dickson, Tenn., a distance of 35 miles.

Dauphin Island.—H. AUSTILL, of Mobile, Ala., writes us that engineers are now at work on this 36 mile Alabama road. About 8 miles of the grading has been completed and work will be resumed in December. The route is through a level country; maximum grades 40 ft. per mile and maximum curve 3°. The principal business of the road will be in lumber, cotton, fish, oysters, grain, and general merchandise. James Wright, 41 Moorgate St., London, England, is the contractor, and F. K. G. WRIGHT of Venetia, Mobile County, Ala., the engineer in charge of construction.

Richmond, Fredericksburg & Potomac.—It is announced that this company has been reorganized and will complete the tunnel at Richmond, Va., and build the line to a ferry connection with the Baltimore & Drum Point R. R., at Piny Point, Va. The contract has been let to Mason, Hoge & Co. The officers of the company are: President, CHARLES W. MACKEY, of Franklin, Pa.; Vice-President, C. E. BELVIN, of Richmond. Directors: C. W. MACKEY, C. E. BELVIN, HORACE B. FRY, WILLIS BARNES, New York; L. F. BOSSIEUX, Richmond. General Manager, HENRY H. TRENOR; Resident Counsel, H. A. ATKINSON, Jr.; Chief Engineer, OLIVER W. BARNES, New York.

Georgia Pacific.—A corps of engineers is being organized to locate a branch line from Baird's to Yazoo City Miss., a distance of about 55 miles.

Charleston & Savannah.—It is reported that the Walterboro branch of this road will be extended to Kearse, S. C., a distance of about 20 miles.

Orlando & Winter Park.—Grading on the extension of this road to Oviedo, Fla., has reached a point about 4 miles beyond Lakemont Park, and it is expected to have the line completed to Oviedo within a month. J. H. ABBOTT, of Orlando, Fla., is Chief Engineer.

East & West Railroad of Alabama.—This company asks proposals for the grading of 8,700 ft. of road bed, comprising about 65,000 cu. yds. of earth excavation. Bids should be addressed to CHAS. P. BALL, Cartersville, Ga.

Chattanooga, Rome & Columbus.—It is stated that this company will build a branch to McLemore's Cove, Ga. It will be between 20 and 30 miles long.

Palatka & Anclote.—About 10 miles of this Florida road has been graded ready for tracklaying and will be completed soon. The road runs from Palatka, through Putnam, Marion, Sumter, Hernando, and Pasco Counties to Anclote, on the Gulf.

Projects and Surveys.

Helena, Tupelo & Decatur.—We have received the following information from HARVEY C. MEDFORD, of Tupelo, Miss., Secretary:

This road is to run from Helena, Ark., via Sardis, Oxford, Pontotoc, Tupelo, and Fulton, Miss., and Isbell, Moulton, and Decatur, Ala. The principal business of the road will be in iron, coal, timber, and cotton. A large portion of the right of way has been secured and large donations of mineral and timber lands have been promised. The surveys have been completed from Helena, Ark., to Tupelo, Miss., and surveys are now in progress from Tupelo east to the iron and coal deposits in Marion County, Ala., a distance of about 48 miles. J. L. FISLEY, of Tupelo, is President.

Paint Rock Coal & Coke Co.—HARRY S. BOSLER, of Oneida, Tenn., Chief Engineer, writes us that this company has just let a contract for building the 4¼-mile line to its coal mines. Work is to begin immediately. The work will be very light with the exception of about 1 mile. The maximum grade will be 3 per cent. There will be one tunnel 400 ft. in length. Dr. H. S. GREENE, of St. Louis, Mo., is President.

Chattanooga & Virginia.—Th's company has completed its organization by the election of the following officers: JOHN A. HART, President; JOHN D. IMBODEN, of Abingdon, Vice-President and General Manager; and ALEXANDER W. CHAMBLISS, of Chattanooga, Secretary and Treasurer. The engineer has been ordered to commence the surveys for the line at once.

Georgia.—The following bills have been passed by the Georgia State Senate: to incorporate the Simmons Short Line, the Florida, Dawson & Northern, the Albany, Florida & Northern, the Augusta, Valdosta & Ocean Pond, the Americus & Jacksonville, the Dublin & Blackshear, the Savannah & Isle of Hope, the Covington & Cedar Shoals, and the Athens railway companies; also a bill to change the name of the Winterville & Smithsonia R. R. Co., and a bill to amend the charter of the Macon & Birmingham R. R. Co. Bills have also been introduced in the Legislature to charter the Jefferson Railroad Co. and the Georgia, Tennessee & Illinois Railroad Co.

Cape Fear & Cincinnati.—The surveys for this road have been completed and it is announced that the contracts for grading the first 60 miles of the road will be let at once.

Virginia Western.—A press dispatch from Wytheville, Va., states that an engineering corps is being formed to survey the line of this proposed road from a point on the Richmond & Allegheny R. R., southwest to Bristol, Tenn. A preliminary survey for the line was run in 1887, but nothing has been done since.

Bowling Green & Northern.—It is stated that Meyer & Morris, of Louisville, Ky., are making a survey of this road preparatory to taking the contract for its construction. The road is to run from Bowling Green, Ky., to a connection with the Chesapeake, Ohio & Southwestern R. R., a distance of 50 miles. M. H. CRUMP, of Bowling Green, is Secretary.

NORTHWEST.—Existing Roads.

Port Arthur, Duluth & Western.—Twenty miles of this road from Port Arthur, Ont., southwest have been completed and construction trains are running. The road is projected to run from Port Arthur to the International boundary, a distance of 85 miles. THOS. MARKS, of Port Arthur, is President.

Louisville, Evansville & St. Louis.—About 1,000 men and trains are now at work on this line between Centralia and Belleville, Ill. It is expected that the grading will be completed by the middle of the month and the track laid through to Belleville by Dec. 1. The line is nearly completed from Mt. Vernon to Walnut Hill Ill.

Northern Pacific & Manitoba.—G. W. Buchanon, the contractor has commenced work on the bridge across the Souris River for the Morris-Brandon branch of this road. It is expected that all the bridging on the line will be completed by Dec. 1.

Northern Pacific.—The line from Little Falls to Staples, Minn., 34.2 miles, recently completed, will be opened for traffic Nov. 17. By the completion of this line the distance between St. Paul and points west of Staples is lessened 27 miles.

Indiana, Illinois & Iowa.—A press dispatch states that this company has made arrangements for the extension of its line from Streator, Ill., to the west shore of Lake Michigan. A traffic agreement has also been made for the use of a certain portion of the Chicago & Indiana Coal Co.'s line from a point near Whitfield, Ind., to La Crosse, Ind. From that point to New Buffalo the Chicago & West Michigan road has been leased. This gives the company a belt line around Chicago, crossing all the principal lines entering the city.

Sioux City & Northern.—Grading is in progress on the section between Leeds, Dak., and Merrill, Ia., 18 miles, and it is expected to have this portion of the road completed in 30 days.

Projects and Surveys.

Marshfield & Southwestern.—Incorporated in Wisconsin to build a railway from Marshfield, on the Wisconsin Central R. R. to a point in Wood County, a distance of about 10 miles. The incorporaters are: ABBOTT LAWRENCE, THOS. H. GILL, J. P. WILBORG, JOHN MARTIN, and WM. SHIMWELL, all of Milwaukee.

Omaha & Pierre.—This company has been organized by citizens of Omaha, Neb., and Pierre, Dak., to build a railway between those two places.

Huron, Chamberlain & Black Hills.—E. T. HARMSTON, of Alpena, Dak., Chief Engineer has sent us the following data concerning this enterprise:

The road is projected to run from Huron, via Alpena, Wessington Springs, Crow Lake, and Pukwana, to Chamberlain, Dak., a distance of 79 miles. The line will be extended to the Black Hills ultimately. The preliminary surveys have been completed from Huron to Chamberlain. The work is light; maximum grade .65 per cent. and maximum curve 3°. The line passes through a fine agricultural country and will have a large business in grain and live stock. About 10 miles of the right of way has already been secured and the remainder can be easily obtained; most of it gratis. A 3 per cent. tax has been voted in aid of the enterprise by Chamberlain, Pukwana, and Lyon Springs in Brule County, Dale., Jerrauld County, and the city of Huron. The contracts for

building the road will be let next spring. D. H. HENRY, of Chamberlain, is President, L. N. LOOMIS, of Alpena, is Secretary, F. E. STEVENS, of Huron, Vice President, and J. T. STEARNS, of Chamberlain, Treasurer.

Black River Falls & Eastern.—HUGH H. PRICE, of Black River Falls, Wis., Chief Engineer, writes us that this road is projected to run from La Crosse, Wis., to Wausau, Wis., a distance of 125 miles. About 25 miles of the line has been surveyed and contracts will be let for building this portion by Jan., 1890. It is expected that tracklaying will begin about May 1, and the road opened for traffic by June 30, 1890.

SOUTHWEST.—Existing Roads.

Denison Rapid Transit.—This 6¼ mile motor road in the city of Denison, Tex., has been completed and opened for traffic.

San Antonio & Aransas Pass.—Grading is reported in progress between Buffalo Bayou and the San Jacinto River on the extension from Houston, Tex., to Alexandria, La.

Red River, Sabine & Western.—It is stated that construction on the division between Palestine and Nacogdoches, Tex., will be commenced in 30 days. L. W. LLOYD, of Nacogdoches, is President.

New Orleans, Fort Jackson & Grand Isle.—Rails for 65 miles of this Louisiana road are now on the ground, and tracklaying has already commenced at Algiers, La. The road is to run from Algiers to Fort Jackson, La., 65½ miles. CHAS. S. DWIGHT, of 25 Carondelet St., New Orleans, La., is Chief Engineer.

New Orleans, Natchez & Fort Scott.—Between 700 and 800 men are now at work on this road grading, bridging, and trestling, and as soon as the incline on the river bank near Natchez, Miss., is completed tracklaying will commence.

Projects and Surveys.

Colmesneil & Alexandria. — It is stated that the Yellow Pine Lumber Co. is building a railway from Colmesneil, Tex., to Alexandria, La., 149 miles. N. W. CARSON, of Colmesneil, is General Manager.

Pittsburg, Columbus & Fort Smith.—Incorporated in Kansas to build a line of railway from Pittsburg south through Crawford and Cherokee Counties, Kan., via Afton and Tahlequah, Indian Territory, to Fort Smith, Ark., a distance of about 195 miles. Among the directors are: JOHN W. BRENER, of Pittsburg, O. J. NICHOLS, of Cherokee, J. P. CAMPBELL, of Columbus, Kan., and H. E. KELLEY, of Forth Smith, Ark.

Kansas City, Nevada & Fort Smith.—This company has been incorporated in Missouri to build a railway from Kansas City, via Nevada, Mo., to Monett, Mo., and ultimately to Fort Smith, Ark. It is thought that it will be operated by the St. Louis & San Francisco R. R. Co., when completed. The officers of the company are, E. L. MARTIN, President; A. E. STILWELL, Vice-President; WM. TAYLOR, Secretary; M. CHURCHILL WHITE, Treasurer.

Missouri Coal & Construction Co.—A company by this name has been incorporated in Missouri. Its object is announced as being, "to buy, hold, and improve real estate and to sell, mortgage, lease, or otherwise dispose of the same; to build, construct, and equip railroads in the State of Missouri and elsewhere under contracts of railroad companies; to mine and sell coal and to carry on the business of dealers in goods, wares, merchandise, provisions, and supplies of all kinds in connection with its business of building railroads and mining coal." Among the stockholders are: E. L. MARTIN, RICHARD GENBRY, CHURCHILL J. WHITE, and WM. WOODS.

Kansas City, Arkansas & New Orleans.—It is stated that work has been commenced on this road, which is projected to run from Beebe, Ark., to Monroe, La., and that 30 miles of the line will be completed by Feb. 1. ADOLPH CUDELL, of Chicago, is President.

Cattle Trail.—The officers of this company, which has been incorporated to build a railway from a point on the Red River south through Texas to Eagle Pass, are: G. T REYNOLDS, President; B. M. LOGAN, Vice-President; D. C. CAMPBELL, Secretary; and F. E. CONRAD, Treasurer.

ROCKY MT. AND PACIFIC.—Existing Roads.

Oregon & Transcontinental.—At a meeting of the stockholders, recently held, resolutions were passed authorizing the reduction of the capital stock of the company $10,000,000; and also the taking of the necessary measures for the dissolution of the corporation, with instructions to the board to discharge all obligations of the company according to law, to sell and dispose of all its assets and property, and after the payment and discharge of all its debts and liabilities, and the settling of its business, to divide the remaining assets among the stockholders. The company was organized in 1881 for the purpose of constructing railways, to secure harmony between the Oregon Railway & Navigation Co., and the Northern Pacific R. R. Co., by purchasing a controlling interest in the stock of both companies, and to furnish means to build and equip branch lines to the Northern Pacific R. R.

Oregon Ry. & Navigation Co.—The Washington & Idaho R. R. from Tekoa, Wash., to Mullan, Idaho Territory, has been completed to a point 54 miles east of Tekoa and tracklaying is now in progress at the rate of 1½ miles per day.

Montana Central.—A dispatch from Misoula, Mont., states that a corps of engineers is being formed to make the surveys for an extension of this road west to Spokane Falls, Wash., or some point on the Pacific coast.

Denver & Rio Grande.—The Rio Grande Southern R. R. Co., has been incorporated in the interest of this company to build a line of railway from Dallas, Ouray County, Col., via Telluride and Rico, to Durango, Col., a distance of 100 miles.— Bids have been called for for the construction of a 2,500-ft. tunnel on the Denver Short Line Ry. near Leadville, Col.

Butte County.—Incorporated in California to build a railway connecting the cities of Oroville and Chico in Butte County. The directors are: J. A. BAXTER, J. W. HARTZELL, D. A. MILLIN, CHAS. H. FORBES, and R. T. HARDING.

Watsonville & Castroville. — Surveys have been made for a 12-mile railway to run from Watsonville to Castroville, Cal. The road will do a freight business only It is stated that construction will commence at once.

RAPID TRANSIT.

Electric Railways.—*Springfield, Mass.*—The street railway company has decided to adopt an overhead electric system, the power for which will probably be furnished by the United Electric Light Co. The change will cost about $20,000, and the company has increased its capital stock to $400,000 to provide the necessary funds.

Troy, N. Y.—The Troy & Lansingburg Ry. Co. has been granted permission by the Railroad Commissioners to extend its electric line through Waterford and Cohoes.

North Adams, Mass.—The electric line to Zylonite has been opened.

Lockport, N. Y.—The street railway company is said to intend building an electric line to Glenwood Cemetery.

Rockford, Ill.—The Rockford Electric Street Ry. Co. will build its line very soon. President, H. N. BAYLISS; Vice-President, LEVI RHODES; Secretary and Superintendent, F. HAINES.

Elgin, Ill.—The Elgin City Ry. Co. has purchased the Payne St. line for $40,000. Nine miles of track will be laid and an electric system adopted.

Waukesha, Wis.—A franchise for an electric line has been granted to FITCH and JARVIS, of Louisville, Ky. The ordinance provides that the wires shall be put underground if the village authorities require it.

Little Rock, Ark.—The Little Rock St. Ry. Co. will put in an electric plant of 300 H. P. and make other improvements at a cost of $75,000.

Portland, Ore.—The electric railway to St. John's has been opened. The Sprague system is used.

Cable Railways.—*Providence, R. I.*—The Providence Cable Tramway Co. has received a grip car and two tow cars from the John Stevenson Co., New York.

Baltimore, Md.—The Baltimore Traction Co. has awarded contracts for converting its lines to the cable system. The cost will be about $3,000,000. Cable cars are expected to be in operation between Druid Hill and Patterson parks by next July. Mr. FRANK H. HAMBLETON is Consulting Engineer.

Los Angeles, Cal.—The cable road to East Los Angeles was opened Nov. 2. In the power house are 2 Hazleton tripod boilers, with Roney mechanical stokers, supplying steam to the engine. The line crosses a viaduct 1,535 ft. long.

Oakland, Cal.—Nearly all the street railway lines, including the Piedmont line, will be converted into one extensive cable railway system, and numerous extensions are being surveyed.

Street Railways.—*Syracuse, N. Y.*—The Syracuse & Geddes Ry. Co. has been granted permission to build an extension to Burnet Park. Side-bearing rails are to be used.—The People's Ry. will be extended to Onondaga Valley; the track will be laid with side-bearing rails, and horse or electric traction may be employed.—The Woodlawn & Butternut St. Ry. will be extended 2 miles. Electric power may be adopted.

Greenville, Miss.—The street railway has been purchased by H. K. JOHNSON, C. E., of Greenville.

Augusta, Ga.—A right of way has been granted to the dummy line company.—A bill to incorporate the Augusta Ry Co. has passed the Senate.

East St. Louis, Ill.—The St. Louis Bridge & Tunnel Co. will build a street railway on Broadway and Collinsville Ave., to connect with tracks over the bridge and into St. Louis.

Peoria, Ill.—The Fort Clark Horse Ry. Co. will apply to the Council, Nov. 19, for the right to build a double track road on several streets.

Athens, Ga.—A bill to incorporate the Athens Street Ry. Co. has passed the Senate.

Staunton, Va.—A street railway franchise has been granted to SAMUEL B. ADAMS and DEAN ADAMS, of Little Rock, Ark.

Elevated Railway.—*St. Louis, Mo.*—A bill has been introduced in the Council to authorize the construction of the North & South Elevated Ry. Co's. line. Six miles are to be in operation within 5 years, and 1 mile per year built thereafter. Steam, electric, or cable traction may be employed. The incorporators are: L. M. RUMSEY, PAUL A. FUSZ, CHARLES D. MCLURE, A. B. EWING, and JOHN M BOFINGER.

HIGHWAYS.

North Carolina.—The Board of County Commissioners at Wilmington, N. C., has received an application asking for a new road in Indian Springs township, from Indian Springs church to the Goodboro and Kenansville road, near Abraham Peel's, and also another asking that the cartway from Mt. Carmel Church, out to the public road near W. B. Fort's in Pikeville township, be made a public road.

Oregon.—The Long Creek wagon road from Pendleton to Canyon City, for which the Legislature appropriated $12,000, is nearly finished. It has been built 25 miles from Pendleton, where it connects with a good road running to Canyon City. Pendleton is already deriving considerable trade from the improvements. Hall, McDell & Patton were the contractors on the Yellow Jouket division; Mr. Smith was the contractor on the Camas Prairie division.—One of the numerous wagon roads for which money was appropriated by the last Legislature is that from Greenville, Washington County, to Olney, Clatsop County, traversing a portion of each of them, and Columbia County. A correspondent of the Nehalem *Journal* says that this appropriation is being rapidly used up, and he commends the work done on the Clatsop and Columbia County portions as fair work—as road work goes—but declares that which has been done in Washington County to be a positive detriment to travel — hilly portions standing on edge without proper support to prevent the descent of the roadbed into the canyons below, while at some places the mud is now impassable to a team with an empty wagon.

Rhode Island.—At Olneyville the Council has made appropriations of several hundred dollars to enable the Commissioner of Highways, Mr. J. WALCH, to carry out improvements on certain roads.

Massachusetts.—The County Commissioners of Franklin County have been petitioned to build three new roads, and will probably order one of them to be built. They will meet on Dec. 17, at Greenfield, to decide upon the location.

Oregon.—Mr. CHAS. S. MOORE, of Linkville, Chairman of the Klamath River wagon road, has awarded the contracts for Sections 5, 8, and 11, to R. A. Emmitt, of Kino Klamath County, at $6,783, $474 and $1,590; total, $8,847.

CONTRACTING.

Tunnel.—The contract for the 8th St. tunnel at Richmond, Va., has been awarded to Mason, Hoge & Co., of Louisville, Ky.

Bulkhead.—Richard V. Breece, of Long Branch, has received the contract for building a big bulkhead at Seabright, N. J., for Washington E. Connor. The contract price is $12,000.

Wharves.—The Fernandina Town Improvement Co., of Fernandina, Fla., will have its wharves rebuilt with creosoted piles and timber.

Street Work.—*Kansas City, Kan.*—The contract for grading 8th St. has been awarded to R. T. Peppers, at 17½ cts. per cu. yd.

Omaha, Neb.—The contract for grading Grove St. has been awarded to T. L. Murphy at 13 cts. per cu. yd.

San Francisco, Cal.—The following proposals have been received: Macadamizing on Webster St.; Champion & Elder, 3 cts. per sq. ft. for macadamizing, $1.20 for crosswalks; Peter McHugh; 3½ cts., $1.09. Horn & McLeon; 3¾ cts., $1.07.—Grading and macadamizing on Hickory Ave.: Peter McHugh, 39½ cts. per cu. ft. for grading, 3½ cts. for macadamizing, 3½ cts. for sidewalks, 14½ cts. for redwood curb. J. G. Conroy & Co.; 60 cts.-41½ cts., 75 cts., 20 cts. C. D. Vincent; 32 cts., 3½ cts., 50 cts., 15 cts.—Paving Buchanan St.: California Bituminous Paving Co., paving 25¾ cts.; sidewalks, $1.25; curbs, $1.10. Pacific Paving Co., paving 27 cts.; sidewalks, $1.10; curbs, $1.13. Santa Cruz Rock Paving Co., 25½ cts., 90 cts., 90 cts.—Paving Union St.: C. B. Williams, paving, 29 cts.; crosswalks, $1.10; curbs, $1.15; sidewalks, 15 cts, Paving Geary, from Van Ness to Franklin: D. Harney, paving, 25 cts.; sidewalks, 15 cts.; curbs, $1.10. J. J. Dowling, 26 cts., 10 cts., $1.00. C. B. Williams, 27 cts., 7 cts., $1.07.

Levees.—The Wood Bros. Land & Improvement Co. has been organized at Kansas City by B. F. WOOD, R. W. WOOD and SAMUEL W. RIDER to build levees and embankments for land reclamation. Capital stock, $100,000.

State House.—The Commissioners of the new statehouse at Boston, Mass., have granted Norcross Bros., of Worcester the contract for the work of construction and all the material except the granite ashlar work, the marble and the iron. Their bid of $622,000 was the lowest of twelve, the highest being $914,000.

Sewer.—*Brooklyn, N. Y.*—The following proposals for a sewer in Degraw St. have been received by J. P. ADAMS, Commissioner of City Works: Daniel J. Creem & Co., $1.50 per ft. for 12-in. cement pipe, $1.75 for 15 in., $38 for manholes, $100 for street basins; John S. Bogert, $1.35, $1.70, $35, $100. Joseph York, $1.25, $1.45, $35, $99.

Hoisting Machinery.—The only proposal for furnishing hoisting plant at shaft 25, received by the Aqueduct,

Commissioners, New York, was from Charles Peterson of 256 W. 57th St., at $11,250.

PROPOSALS OPEN.

Masonry.—About 1,500 cu. yds. of bridge pier masonry, OLIVER FERGUSON & SON, railway contractors, Bedford, Ind.

Broken Stone.—Purchase of about 50,000 cu. yds. of broken stone excavated on the Harlem River improvement, Lieut.-Col. G. L. GILLESPIE, U. S. Engineer Office, Army Building, New York City, Nov. 18.

City Work.—Sewers, paving, grading, bridge repairs, etc., LOUIS WAGNER, Director of Public Works, City Hall, Philadelphia, Pa. Nov. 18.

Water-Works and Drainage.—Plumbing, drain and water system. L. FEBIGER, U. S. A., Fort Wayne, Mich, Nov. 19.

Water-Works.—Bids to be opened at Wymore, Neb., for works to cost about $30,000. A. A. RICHARDSON, C. E., Lincoln, Neb. Nov. 19.

Bridge.—Over the river at Main St.; 330 ft. long; cost about $7,000. THE CITY CLERK, Greenville, S. C. Nov. 20.

Artesian Well.—Depth not exceeding 900 ft., iron casing, 6 ins. outside diameter. F. L. CLISBY, Village Clerk, Parker, So. Dak. Nov. 20.

Supplies.—At Norfolk navy yard; 12 globe valves, 490 lbs. tool steel, pipe and fittings, copper tubes, iron washers, Tobin bronze, paint, etc. JAMES FULTON, Paymaster-General U. S. N. Navy Department, Washington, D. C. Nov. 21.

Street Work and Sewers—Laying crosswalks and building sewers. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. Nov. 22.

Street Work.—Granite block paving, limestone curbing, granite crossings. THOS. G. SMITH, President of Board of Public Affairs, Cincinnati, O. Nov. 22.

Harbor.—Work in harbor at Southampton, Ont. A. GOBEIL, Secretary, Department of Public Works, Ottawa, Canada. Nov. 23.

Bridges.—Lift bridges over the Erie canal at Geneva St., Lyons, N. Y., and Caledonia Ave., Rochester, N. Y. Separate bids for substructure and superstructure; and the latter must include royalty on patent. JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y. Nov. 26.

Railway.—Grading and masonry on a branch line in Montgomery County, Pa. J. U. CRAWFORD, Asst. to 2d Vice-President, Pennsylvania R. R. Co., 235 So. 4th St., Philadelphia, Pa. Nov. 30.

Jetties.—Jetties and shore protection of piles and stone at Cape Charles light station, Virginia. Capt. J. C. MALLORY, U. S. Lighthouse Engineer, Baltimore, Md. Nov. 30.

Bulkheads.—Repairing bulkheads at Union St. bridge. J. P. ADAMS, Commissioner of City Works, Brooklyn, N. Y. Nov. 25.

Bridge.—Iron bridge over the Cumberland River; 300 ft. c. to c. of abutments, 16 ft. roadway; moving load of 1,280 lbs. per lin. ft. A. L. MONROE, Pineville, Ky. Dec. 2.

Iron Work and Building Material.—About 230 lbs. of button-head bolts and nuts, 15,750 lbs. of plates, 4,384 lbs. of tee and angle iron. Also brick, stone, lime, cement, etc. JAMES FULTON, Paymaster General, U. S. N., Navy Department, Washington, D. C. Dec. 3.

Street Work.—Grading, curbing, paving, culverts, etc. THOS. G. SMITH, President, Board of Public Affairs, Cincinnati, O. Dec. 10 and 11.

MANUFACTURING AND TECHNICAL.

The Santa Cruz Bituminous Rock Pavement Co. has been organized at San Francisco, Cal., by GEO. M. PERINE, J. F. FARLEY and J. J. DUNNE. Capital stock, $10,000.

Asphalt Blocks.—A company has been organized at Fort Payne, Ala., to manufacture asphalt paving blocks. President, HENRY B. PIERCE, General Manager, J. H. MENDALL. Capital stock, $40,000.

The Tacoma Contract Co. has been organized at Tacoma, Wash., by E. B. CUSHING, F. A. SMALLEY and GEO. M. SAVAGE. Capital stock, $100,000.

Ferry Boat.—The Polson Iron Works, of Toronto and Owen Sound, have contracted with the Canadian Pacific to construct a second ferry steamer for use on the Detroit River. The new boat will be 295 ft. long, and will be a duplicate of the one now nearly ready to be commissioned. The vessels will be used in transporting trains across the Detroit River between Windsor and Detroit.

Car Heating.—The Illinois Central R. R. will have two engines fitted up to furnish steam for heating trains between Kankakee and Chicago. Stoves will be discarded.

Signals.—Four Gould-Tisdale revolving semaphores have been placed in operation at the Fish Creek Bridge on the Rome, Watertown & Ogdensburg. The bridge is single tracked and is used by both the Rome, Watertown & Ogdensburg and Elmira, Cortland & Northern. The former company is considering the adoption of the system for grade crossings and several of its officials have inspected the semaphores. The signal is operated by electricity. In front of the operator is a small counterpart of the signal board, and the position of the latter on the track is indicated by the counterpart and a bell in the station. The signal is at danger when in its normal condition, and shows a clear track only when changed by the operator. The arm of the semaphore is placed in a circular case with glass sides. This signal has been in use for some time on some New England roads.

The U. S. Construction Co., of Chicago, has been organized by JAMES C. MCSHANE, JOSEPH MCHOLMES and J. B. CROWE. Capital stock, $250,000.

Switches.—The Frogless Switch Co. has been organized at Richmond, Va., by J. T. ODELL, C. W. P. BROCK and H. T. WICKHAM. Capital stock, $100,000.

Cement.—The Cumberland Cement Co., of Cumberland, Md., is building two new kilns, which will increase the daily capacity of the works from 500 bbls. to 600 bbls.

The Kimball Car Heating System.—The Kimball Automatic Car Heating Co. has been organized at Portland, Me., and a car heated on this system is running on the Portland & Rochester R. R. The system combines steam and water heating, and the company is said to control the only patent issued for a combined system of steam and hot water heating. The pipes run through the cars similar to those of other systems, but there is much less pipe used. Each side of the car may be heated independently of the other, and the temperature is regulated by a thermostat in each end of the car, each controlling one side. As the temperature rises, the steam valve is closed automatically, securing an even heat at all times, and without attention from the train-hands. The steam is taken direct from the locomotive, is fed to each car through the train supply pipe, and is so handled as to be furnished dry to each car in the train.

Locomotives.—The Cumberland & Pennsylvania Railroad has shipped from the Mt. Savage shops a narrow-gauge passenger locomotive, weighing 20 tons, to the Tunnelton, Kingwood & Fairchance Railroad, at Tunnelton, W. Va.

A new type of passenger engines, "Class O," recently turned out from the Altoona shops of the Pennsylvania road are receiving considerable attention. They are eight-wheel passenger engines, weigh nearly 99,000 lbs., and have 68-in. driving wheels. The boiler is of extra size. The steam dome is set forward on the boiler, and an auxiliary dome provided for supplying the whistle, etc.

The Pond Engineering Co. has the contract for the steam plant at the new Thomson-Houston lighting station at Joliet, Ill. There will be three boilers of 100 H. P., one Lane & Bodley Corliss engine, of 250 H. P., Hoppes live steam purifier, Lowe heater, pump injector, etc. The station will be completely equipped. The company will also furnish the San Diego, Cal., cable railway with four boilers of 90 H. P., and the Palmetto Brewing Co., Charleston, S. C., with a Lowe heater of 100 H. P.

Shay Locomotive.—This engine is designed for lines with steep grades, sharp curves and rough track. They are Forney tank engines, with two four wheel trucks. Three vertical cylinders are placed at one side of the firebox and drive a shaft which operates bevel gears on the faces of the four wheels on that side of the engine. Ball and socket joints allow for free movement of the tracks. These engines are in use on coal roads in Pennsylvania and Colorado. The Southern Equipment Co. has been organized to build these engines for Southern roads. The incorporators are J. R. RYAN, F. EASTMAN and G. M. CHAPMAN.

Artificial Stone.—The Lichtentag Patent Stone Co. has been organized at Mobile, Ala., to manufacture a patent stone pavement; S. RICHARD, H. PISER and J. L. RAPIER. Capital stock, $50,000.

Gunboats.—At Philadelphia, Pa., a company has been formed by New York, Philadelphia and New Haven capitalists to build twin-screw seagoing gun and torpedo boats. Three of these boats are to be contracted for very soon. D. GATLING, the inventor of the Gatling gun, is general manager, and has decided that the boats are to be built on the Delaware River. Capital stock, $6,000,000.

Cars.—Pennock Bros., of Minerva, O., have a contract for 600 coal cars for the Pittsburg & Western.

The Litchfield Car & Machine Co., of Litchfield, Ill., has a contract for 200 box cars for the Cincinnati, Washington & Baltimore.

The Indianapolis Car Works, of Indianapolis, Ind., are building 900 coal cars for the Pittsburg & Western.

The Terre Haute Car Works, of Terre Haute, Ind., are building 100 stock cars for fast stock-train service. They are 34 ft. long equipped with air brakes and automatic couplers.

The St. Charles Car Co., of St. Charles, Mo., is building 300 coal cars and 50 cabooses for the Wabash, 200 box cars for the St. Louis & San Francisco and some large oil tank cars.

Market Prices—*Rails.*—New York and the East; $32 to $34, with a probability of a raise to $35; $30 for 30 lb. rails; $24.50 to $25 for old rails. Pittsburg; $33 to $34 at mill; old steel rails, $21.50 to $22.50. Chicago; $33 for 1890 delivery; old steel rails, $19.50 to $20.

Track Materials.—Pittsburg; spikes, 2.10 cts., 30 days f. o. b.; splice bars, 2 cts.; track bolts, 3 cts. with square and 3.10 cts. with hexagon nuts. Chicago; soft steel splice bars, 2.15 to 2.20 cts.; iron splice bars, 1.97½ to 2.05 cts.; spikes, 2.25 to 2.30 cts.; track bolts, 2.80 to 2.85 with square and 2.90 to 2.95 cts. with hexagon nuts.

Scrap.—Chicago; dealers selling prices per net ton; No. 1 forge, $21 to $22; No. 1 mill, $16.50; No. 2 mill, 11.50; car-axles, $25.50; fish-plates, $22; pipes and flues, $15; cast machinery, $14; cast borings, $8.50; wrought turnings, $12.50; axle turning $14; coil steel, $18; leaf steel, $18; locomotive tires, $18; mixed steel, $15; mixed country scrap, $17.

The Atlas Hydraulic Screw Elevator is a new device made by the Springfield Foundry Co., of Springfield, Mass., and 108 Liberty St., New York. The peculiarity lies in the horizontal screw shaft connected with a piston-head operated by water-pressure, either from the street mains or a tank in the building supplied by a pump. This screw-shaft is in line with and acts upon the hoisting drum of the elevator, and converts horizontal motion into rotary motion. The advantages claimed are that the friction and the severe straining of the wire cables is less than in the ordinary differential-pulley or sheave-hoisting machines, and the cost of maintenance is thus much smaller. Also 50 per cent. more power is obtained from the same cylinder diameter, resulting in a great saving of water used. As an example, 163 galls. of water at 100 lbs. pressure in a 20-in. by 10 ft. Atlas cylinder raises a load of 2,000 lbs. 100 ft. in 30 seconds. It is fitted with automatic safety appliances and arrangements for stopping the car.

Dredge Grapples.—JAMES H. LANCASTER, of New York, has recently sold one of his self-closing grapples to Brownell & Murkland, of New Bedford, Mass., for building a bulkhead at that place. Also one to Cumming & Conner of Stockport, O., for excavating for the caissons of the new bridge over the Ohio, at that place; and a third to Amsink & Co., shipped to the Carribean Sea for raising rock phosphates blasted under 15 ft. of water.

Gas Machine.—The California Water, Gas-light & Fuel Co. has been incorporated at San Francisco, to manufacture and sell an automatic gas machine. The capital stock is $250,000. Directors: HENRY PEASE, L. S. STARKWEATHER, J. H. RUSS, J. W. BROWN, and D. C. SCOTT.

Materials Wanted.—About 3,000 ft. of 40-lb. steel rails, 1,600 ft. of cast steel wire rope, dump cars of 12,000 lbs. capacity, iron sheaves, etc., for incline railway for stone quarries. Also plans and specifications for either a two-rail or three-rail plant, with switch in the middle. Venable Bros., Atlanta, Ga.

A tubular boiler of 25 H. P. P. O. Box 79, New Orleans, La.

Dynamo, for 8 arc lights. S. W. Baird, 402 Mermod & Jaccard Building, St. Louis, Mo.

BRIDGES AND CANALS.

Bridge Notes.—***New Haven, Conn.***—The Board of Public Works has adopted estimates for the following work for next season: Chapel St. railway bridge, $11,000; Webster St. railway bridge, $2,600; DeWitt St. railway bridge, $3,000; Rock Lane bridge and approaches, $5,500 Derby Ave. bridge, $6,000; two bridges, Bridge St. causeway, $3,000; repairs, planking, etc., $5,500; Orange St. bridge, $15,000.

Gowanda, N. Y.—The Groton Bridge Co., of Groton, N. Y., is building an iron bridge across the Cattaraugus. It is 153 ft. span, and will cost $11,000.

Hancock, N. Y.—The New York, Lake Erie & Western Ry. is building a double-track iron bridge over the Delaware.

Allegheny, Pa.—The Trans-Allegheny Traction Co. may purchase the 6th St. bridge or build a new one near it.

Louisville, Ky.—The contract for the substructure of the Ohio River bridge has been let to Sooysmith & Co., of New York. The Phœnix Bridge Co., of Philadelphia, Pa., has the contract for the superstructure.

Natchitoches, La.—A company has been organized to build and maintain a bridge across the Cane River.

Danville, Ind.—The Lafayette Bridge Co. has the contract to build a bridge over the Vermillion River for $15,000.

South St. Paul, Minn.—An iron bridge is to be built at a cost of $300,000. For particulars address the City Engineer, Mr. WEYMOUTH.

Topeka, Kan.—The proposition to issue bonds for a bridge has been defeated by a public vote. The present bridge is said to be in an unsafe condition, but the cost of the proposed new bridge was considered too high.—The contract for a bridge over Post Creek has been awarded by the County Commissioners to the St. Louis Bridge Co. for $947; and for another over Six-Mile Creek for $747.

Little Rock, Ark.—A commission, consisting of W. G. WHIPPLE, S. S. WASSELL and GEO. R. BROWN, has been appointed to report on site, plans and specifications for the new bridge across the Arkansas River.

Denver, Col.—A new bridge is projected across the Platte river at 3d Ave. It will be built by the County Commissioners and the Board of Public Works.

Brandon, Man.—The Souris River bridge of the Morris & Brandon branch of the Canadian Pacific Ry. is being built by G. W. BUCHANAN. The span is 180 ft. with trestle approaches.

St. Clairsville, O.— The County Commissioners of Belmont County have received the following proposals for an iron bridge with one span of 140 ft.: Columbia Bridge Co., Dayton, O., $2,699; Massillon (O.) Bridge Co., $2,940; Smith Bridge Co., Toledo, O., $2,940; King Bridge Co., Cleveland, O., $3,045.23; Variety Iron Works Co., Cleveland, O., $3,080; Pittsburg Bridge Co., $3,080; Indiana Bridge Co., $3,119; Queen City Bridge Co., Cincinnati, O., $3,200; J. P. Bracket, Cincinnati, $3,234; Mt. Vernon (O.) Bridge Co., $3,290; Champion Bridge Co., Wilmington, O., $3,290; Canton (O.) Wrought Iron Bridge Co., $3,311; Youngstown (O.) Bridge Co., $3,354; Penn Bridge Co., Beaver Falls, Pa., $3,581; Columbus (O.) Bridge Co., $3,584. The contract was awarded to the Variety Iron Works Co., of Cleveland, at $3,080.

Atlanta, Ga.—The following proposals have been received for the construction of the Chattahoochee River bridge. The contract will be awarded to the Atlanta Bridge & Axle Co.

Atlanta Bridge & Axle Co	$13,350
Geo. H. Crafts, Atlanta, Ga	13,554
W. H. Converse, Chattanooga, Tenn.	13,770
King Iron Bridge & M'f'g. Co., Cleveland, O.	13,900
Columbus Bridge Co., Columbus, O.	14,010
Massillon Bridge Co., Massillon, O.	14,300
Youngstown Bridge Co., Youngstown, O.	14,500
Moore & Bullen, Decatur, Ala.	14,625
Groton Bridge Co., Groton, N. Y.	14,920
Pittsburg Bridge Co., Pittsburg, Pa.	15,000
Southern Bridge Co., Birmingham, Ala.	15,200
Champion Bridge Co., Wilmington, O.	15,975
Milwaukee Bridge & Iron Works, Milwaukee, Wis.	17,378
A. V. Gude, Atlanta, Ga.	24,000
Millikin Bros., New York	28,758.37

Harbors.—***Galveston, Tex.***— The Galveston Deep Water Channel & Dock Co. has been incorporated, and proposes to obtain a depth of 30 ft. of water for the harbor. Capital stock, $2,000,000.

Huntington, N. Y.—The citizens of Huntington, L. I., have appointed a committee of twelve to take steps to secure from Congress an appropriation for the dieging out of Huntington Harbor. According to the report of the Chief Engineer of the First District, in 1885, about $42,000 would be required for the work. An appropriation of $25,000 was made, but this was exhausted in 1872. The expenditure, however, resulted in the accomplishment of much good.

Ohio River.—The West Virginia & Ironton R. R. Co. proposes to build a bridge over the Ohio River about 1¼ miles above the mouth of the Big Sandy River, and will submit the plans to the Secretary of War on Nov. 19, President, Jos. I. DORAN; Secretary, CHAS. H. MELLEN. The road will be a part of the Norfolk & Western Ry., the offices of which are at Roanoke, Va.

Canals.—***Florida.***—The Florida East Coast Canal & Transportation Co. proposes to build a canal connecting the Matanzas and Halifax Rivers.

Michigan.—Surveyor DORR SKEELS thinks the new canal between Grand Rapids and Holland could be made, but it would cost a good deal of money. The principal obstacle in the way is an elevation that crosses the swamp below Hudsonville, where, for a distance of 3 miles, is an elevation of about 30 ft. above Lake Michigan. The level of the river at Grand Rapids below the island is only 5½ ft. above the head waters of Black Lake, 2 miles from Holland. The soil where the extreme height of land occurs is a bed of muck about 40ft. in thickness, and can be easily excavated; and although one or two locks would be necessary, there is no insurmountable obstacle in the way of a ship canal.

The Elmira Bridge Co., of Elmira, N. Y., has commenced operations, and is now turning out bridges. It is expected the works will be in full operation by Dec. 1. The machinery and buildings are designed for the construction of the heaviest class of work. Girders are at present being made up to 20 tons in weight. It is the intention to build the heaviest class of railway work.

ELECTRICAL.

Electric Lighting.—***Laconia, N. H.***—The Winnipiseogee Gas & Electric Light Co. has been organized as follows: President, JOHN S. CRANE, of Lake Village; Vice-President, S. B. SMITH, of Laconia; Secretary, F. EDGERLY. The company proposes to purchase the plant of the Laconia Electric Light Co.

Newport, R. I.—The bid of the Edison Illuminating Co., which competed with the Newport Illuminating Co. for the street light contract, was for 75 arc lights, Thomson-Houston system, 2,000 c. p., 50 cts. per light per night; for all additional up to 100, 50 cts.; all additional over 100, 45 cts; for 365-nights in the year 2 cts. per night less, or 48 and 43 cts.; for the incandescent lights by meter, 1 ct. per hour for 16 c. p., 1¾ cts. for 32 c. p.

Bath, N. Y.—At the regular meeting of the trustees on Nov. 9 the question of lighting the village with electric lights was discussed and the clerk ordered to advertise for 40 lights of different systems.

Jersey City, N. J.—Mayor CLEVELAND has vetoed an ordinance recently passed by the City Council allowing the Bergen Electric Light Co. to erect poles, string wires and lay pipes, in and under the streets for the purpose of supplying light, heat and power.

Columbia, S. C.—The Congaree Gas & Electric Light Co. will put in a Thomson-Houston incandescent plant.

Blacksburg, S. C.—The Blacksburg Land & Improvement Co. will put in an electric light plant. The incorporators are J. F. JONES and FRANK COXE, of Asheville, JOHN G. BLACK, and others. Capital stock, $10,000.

Massillon, O.—The council has made a contract with the Massillon Electric Light Co.; there will be 90 arc lamps at $90 each per year, if burning all night, and $70 if burning only until 1 A. M.

Columbiana, O.—An electric light contract has been awarded to J. C. Thullen at $1,250 per year for 5 years.

Winchester, Ind.—A local company has been awarded a contract for electric lighting.

Duquoin, Ill.—The Duquoin Light, Heat & Power Co. has been incorporated by J. R. THUESDALE, D. SHEPARD, and R. M. FOSTER, of St. Louis. Capital stock, $50,000.

Duluth, Minn.—The Duluth Electric Co. has been reorganized as the Hartman Electric Co., and has increased its capital stock from $150,000 to $250,000. The incorporators are A. W. HARTMAN, R. A. COSTELLO, C. E. VAN BERGEN, and others.

St. Charles, Mo.—It is proposed to put in an electric light plant, to be owned and operated by the city. A committee has visited St. Louis to inquire into the workings of the municipal system in that city.

Holden, Mo.—An electric light franchise for 20 years has been granted.

La Grange, Tex.—The La Grange Water, Electric Light & Power Co. will put in its plant shortly. For particulars address Mr. W. S. ROBSON.

La Grande, Ore.—The La Grande Edison Electric Co. has been organized by A. H. KERBY, W. H. MCDONALD, and H. ASSER. Capital stock, $15,000.

Ingersoll, Ont.—The Heisler Electric Light Co., of St. Louis, Mo., has a contract for 60 incandescent lights of 30 c. p. at $16.50 each per annum, and 10 arc lights of 2,000 c. p. at 20 cts. each per night.

The Electrical Construction Co. has been incorporated at Baltimore, Md., by C. W. HUNTINGTON, H. G. LEE, and T. W. R. DUVALL. Capital stock, $12,000.

Newport, R. I.—The Committee on Street Lighting has submitted proposals for street lighting. The recommendation was that the city contract for three years with the Newport Illuminating Co. for 75 arc lights of 2,000 c. p., Thomson-Houston system, to burn from dusk to dawn no less than 26 nights a month each light, at 50 cts. per light per night; with the Newport Gas Light Co. for gas for street lights and for city buildings and offices, as required, at $1.50 per 1,000 ft.; and with the same company for one year for supplies for street lights: cast-iron lamp posts, $7.50; square copper lanterns, $5.50; cross bars, $1; gas cocks, 80 cts.; 5-ft. glycerine burners, 75 cts. glass per square, 14 cts.; and with the Globe Gas Light Co., of Boston, for naphtha street lights, as required for one year, not less than 26 nights per month, at 9 cts. per light.

Bombay, India.—Proposals will be received by E. C. K. OLLIVANT, Municipal Commissioner, until Jan. 9, 1890, for the experimental lighting by electricity of the main road from the Crawford Markets to the end of the Apollo Bunder. Firms willing to undertake the experiment (for which no longer period than two years will be guaranteed) are invited to submit, by the aforesaid date, full particulars as to the system or systems which they may propose to adopt, either wholly or in part, the number and position of lamps to be erected, the illuminating power, and the rates to be charged monthly. It will be optional for the contractor to bid also, with similar particulars, for all or any of the following extensions: 1. Crawford Markets (interior); 2. Church Gate St. and Elphinstone Circle; 3. Colaba. A free site for the location of the machinery during the period of the experiment will be allowed by the municipality, at or in the immediate neighborhood of the Crawford Markets. Should the contractor require any other site for machinery, he will have to make his own arrangements in respect thereof. No overhead wires in any street will be permitted.

On application at the office of Messrs. E. W. & R. Oliver, solicitors, 1 Corbet Court, Gracechurch St., London, England, a printed slip, giving information as to the hours of lighting and a map of the section of the city to which this notice refers, can be obtained on payment of $5. Duly authenticated testimonials from the municipal authorities of any town in which firms tendering response to this notice may have already conducted operations will receive special consideration.

The Heisler Electric Light Co., of St. Louis, Mo., has sold an electric lighting plant to the Lafayette Car Co., for its yards and buildings at Lafayette, Ind. A dynamo and lamps have been sold to the Rawson & Root Lumber Co., of Michigan City, Ind., which has been using the system for about a year and now intends to supply lights to manufacturers.

SEWERAGE AND MUNICIPAL.

Bonds.—The city of Sioux Falls, So. Dak., will sell $180,000 funding bonds on Dec. 16. Mr. W. H. HOLT is City Auditor.

Street Work.—***Albany, N. Y.***—The West End Improvement Association proposes to have Ontario St. and other streets paved and improved.

Denver, Col.—The streets are said to be in a very bad condition, and little action has been taken by the Board of Public Works in regard to a system of paving, except to build crosswalks. The Denver *Republican* says: "Stone crossings may be very well in their way, but they will not satisfy the popular demand for paved streets. Until the streets are paved, it will be absurd to expect that any kind of crossings will prove satisfactory. When the whole surface of the street is mud in motion, as it is now every time there is a storm, it is impossible to keep any sort of crossings clean, especially on streets that have an incline. The mud is sure to sweep over the crossings, and it cannot be kept off. The thing to do is to get rid of the mud, and that can only be done by paving the streets."

Managua Nicaragua.— The President has signed a decree empowering the municipality of Managua to borrow $40,000 for the purpose of repairing the streets, building a prison, and finishing the new city hall.

City Hall.—The Kansas City Board of Public Works has instructed Superintendent of Buildings S. E. CHAMBERLAIN to prepare the plans for the foundation and superstructure of the new city hall. The plans of the new building to be erected by the city next year have been prepared by Assistant Superintendent of Buildings CURTIS, and as prepared, have met the ideas of the members of the board, the members of the committe on public buildings and grounds, and they will be adopted as drawn.

Jail.—A new county jail is to be built at Visalia, Cal., at a cost of $27,000.

Gas Lighting.— The New York gas companies are experimenting with improved forms of gas burners for street lamps. One of the best of these is the Siemens regenerative burner, the charge of which to the city is $60 each per annum.

Sewers.—***Bennington, Vt.***—Surveys are being made for a system of sewers and street grading.

Providence, R. I.—The first contract to be awarded for the building of the new sewers, which are to cost between $5,000,000 and $8,000,000, has been awarded to Moulton & O'Mahoney, of Lawrence, Mass. The contractors have begun work on disposal division No. 3 of the improved sewerage system, at Field's Point.

Troy, N. Y.—The improvement commission has agreed to determine at one time the material for sewers, their location and size, and the location of the manholes. It has been decided not to build any sewers during the winter. The City Engineer, Mr. BAERMANN, has sent out inquiries to 60 cities, asking for information as to their experience with sewerage systems.

Baltimore, Md.— The mayor has signed the ordinance appropriating $275,000 out of the $5,000,000 loan to construct a sewer to relieve certain streets from flooding.

Jacksonville, Fla.—A vote will be taken in December on a proposition to issue $750,000 for sewers. It is proposed to build about 12 miles.

Seattle, Wash.—The topographical surveys of the city made for the new water-works will be utilized in laying out the sewerage system. The City Engineer, Mr. SLURRY will have charge of the work, and Mr. BENEZETTE WILLIAMS, of Chicago, will be Consulting Engineer.

Thompsonville, Conn.—Sewers are to be built in several streets at a cost of $6,500.

Sewage Disposal.—***Los Angeles, Cal.***—The Pacific Sewage Co. has made an offer to take all the sewage and convey it in pipes to suitable filter beds, for $150,000, and to handle the sewage for $8,000 a year, for 50 years. The offer was not accepted. Mr. JOSEPH HANNON has offered to receive the sewage at or near the intersection of Santa Fé Ave. and the southern city boundary, and to conduct the same to suitable land, embracing not less than 40 acres, and to pipe the small portion that cannot be diverted to San Pedro St. or Santa Fé Ave. inside of the city limits, to lands now watered by the South Side Irrigation Co., for $116,000, payment to be made as the work progresses. He further agrees to receive all said sewage delivered at or near Santa Fé Ave. and the southern boundary of the city, and filter and deodorize the same, summer and winter, for ten years, for $6,000 per year. At the termination of ten years he will deed to the city pipe lines, right of way, and filter beds, with sufficient land to operate the same, for the sum of one dollar. He represents the West Sewage Co. New bids will be advertised for.

Toronto, Ont.—A trial is to be made of the Conder system of sewage deodorization. Mr. C. W. MAYNE, of Kingston, Ont., is the company's representative.

WATER-WORKS.

NEW ENGLAND.

Orono, Me.—The town has voted to build works. ALBERT WHITE is Town Clerk.

Bucksport, Me.—A satisfactory test of the new works has been made.

Camden and Rockland, Me.—The Camden & Rockland Water Co. has connected West Camden and Lake Mile, with a new 16-in. main. The company now has two mains to West Camden, where one main supplies Camden Rockport and Thomaston.

Caribou, Me.—The new works were successfully tested

on Nov. 7. Water power pumps raise water from Aroostook Creek to a stand-pipe. M. M. TIDD, was Consulting Engineer.

Barton, Vt.—The new works have been put in operation.

Winooski, Vt.—The old hydrants are being replaced with new ones throughout the village. Complaints are being made of the quality of the present supply, and it is reported that extensive improvements are to be made in the spring.

New Bedford, Mass.—Superintendent R. G. P. COGGESHALL is reported as stating that about 3 or 4 miles of new mains will be laid next season.

Westerly, R. I.—A committee has been appointed by the Westerly Fire District to ascertain and report the best arrangement that can be made with the Westerly Water-Works Co. for supplying water for fire protection.

Litchfield, Conn.—The water company has contracted with J. S. Smith, of New York, and Seth Pratt, of Litchfield, for building a reservoir for their water supply, at $15,000. The dam is to be 500 ft. long and 25 ft. high. The reservoir will cover five acres. Work is to be completed by Oct. 1, 1890. M. S. Drummond, of New York, has been awarded the contract for furnishing the pipe, at $18,000.

Thompsonville, Conn.—The company is to add 2' ft. to the height of its stand-pipe.

East Hartford, Conn.—The Legislature has passed an act authorizing the company to increase its capital stock to $100,000.

MIDDLE.

Cohoes, N. Y.—The City Engineer has been instructed to ascertain the cost of laying a considerable amount of new mains.

Silver Springs, N. Y.—The new works have been completed, but are not entirely satisfactory to the citizens.

Utica, N. Y.—City Surveyor EDGERTON is preparing plans for a water supply system for the Widows and Orphans' Home, and a school, to be erected by the Grand Lodge of Free and Accepted Masons. Address E. M. L. EHLERS, 23d St. and 6th Ave., New York.

Lawrenceville, Pa.—A new source for the city's supply is being discussed.

Oil City, Pa.—Bids are wanted for furnishing two tanks for a high service system to be established on Rich Hill, South Oil City. About one mile of 8-in. pipe will be laid.

Allegheny, Pa.—The city is still discussing the question of a new source of supply, and the following plan has been submitted to the City Council by Superintendent EDWIN ARMSTRONG, for taking the supply from the Allegheny River. To lay a 60-in. steel conduit, 9-16-in. thick, to Six Mile Island, at a cost of $600,000; erecting a Hyatt filter, $175,000; engines and rip-rap work, $16 0,000; total cost $935,000.

SOUTHERN.

Henderson, N. C.—We have received the following information from J. H. BRIDGES, Town Clerk:

Bids will soon be wanted from contractors for constructing works. The Legislature has granted a charter to a company, but no plans have been drawn and nothing definite done.

Union, S. C.—Address JAMES H. RODGER for information regarding the proposed works.

Blacksburg, S. C.—The Blacksburg Land & Improvement Co. has been organized to build works. The trustees are: JOHN F. JONES and FRANK COXE, of Asheville, JOHN G. BLACK and others. The capital stock is $10,000.

Atlanta, Ga.—A report has been submitted to the City Council by Consulting Engineer RUDOLPH HERING, of New York, in which a general outline of the condition of the present system, quality of water, etc., are given, and a plan recommended for obtaining a supply of pure water, adequate for the city's present needs, and so arranged as to be easily enlarged for all future requirements.

Jacksonville, Fla.—A vote is to be taken in December on the question of issuing $750,000 of improvement bonds. A considerable amount of improvements, including the laying of 12 miles of new mains, will be made to the works, if the bonds are carried.

Mobile, Ala.—The City Council has decided to place check valves on all hydrants to prevent the slack on account of high pressures.

Oxford, Miss.—A vote on the question of constructing works will be taken on Dec. 2.

Alexandria, La.—The City Council has passed a resolution to the effect that correspondence be opened with contractors on the subject of works, and bids solicited for their construction.

Donaldsonville, La.—The following resolution has been unanimously adopted by the City Council:

That an annual tax of one per cent. on the taxable property in the town of Donaldsonville be annually levied and collected for a period of 10 years, or so long as may be necessary and that the proceeds of said levy be and hereby are, specially appropriated and set aside for the purpose of providing a fund for the erection and construction of a system of water-works and electric lights in said town; this ordinance to remain in force and effect until said water-works and electric lights are fully constructed and paid for.

Address E. N. PUGH, Mayor, or L. E. BENTLEY, City Secretary.

Johnson City, Tenn.—The Johnson City Water-Works Co. has been incorporated to build works. The incorporators are: W. S. CAMPBELL, J. E. CRANDALL, R. J. LUSK, and others. The supply will probably be brought from Indian Creek, 9 miles distant, by a 36-in. main.

Ludlow, Ky.—Works are projected. Address the City Clerk.

NORTH CENTRAL.

Owosso, Mich.—W. H. Myers & Son have abandoned their contract. The Water-Works Committee has taken charge of construction, and work is progressing rapidly.

Fort Wayne, Mich.—Sealed proposals in triplicate will be received until Nov. 19, for improvements to the water supply in connection with the barracks. Address LEA FERIGER, R. B. M., 23d Infantry, A. A. Q. M.

Chicago, Ill.—A petition has been presented by the Hydraulic Machinery & Power Co. for the passage of an ordinance granting them a franchise to establish a high pressure system of works.

Burlington, Wis.—The town has voted to construct a $20,000 system of works. Address H. E. ZIMMERMAN.

West Superior, Wis.—The rights of the Draft Light Co., the Superior Water Co. and the Superior Arc Light & Power Co. have been purchased by, and the three companies merged into, the Superior Water, Light & Power Co. Additional mains will be laid, and other improvements made, by the new company. JOHN MATHER is General Manager.

NORTHWESTERN.

Mankato, Minn.—The city has sold its recent issue of $40,000 of improvement bonds at a premium of $657.

Little Falls, Minn.—It is reported that Harrison & Hawley, of St. Paul, are preparing plans for a system of works.

Fort Snelling, Minn.—Harrison & Hawley, of St. Paul, have been awarded the contract for making the extensions.

Marshall, Minn.—The town has voted in favor of constructing works. Address S. N. HARRINGTON, Recorder.

Alexandria, Minn.—Thirty 2½-in. wells are to be sunk from which to draw the supply. A 1,000,000-gall. Worthington pumping engine is now being placed in position. E. T. Sykes & Co., of Minneapolis, are the contractors.

St. Paul, Minneapolis, and Stillwater, Minn.—The question of a joint water supply for the two former cities, of sufficient capacity to allow of its extension to the latter city, is again being discussed in the St. Paul Chamber of Commerce. It is proposed to bring the supply from Miles Lacs. G. W. SMALLEY in his remarks stated: "The subject of a common water supply is of vital importance, it will take a long time to carry out the project, and it is none too early to take the preliminary steps looking to it." He also favored the appointment of a joint water board, which should have as its work the collection of all details relating to a project of this character.

Smith's Center, Kan.—The contract for furnishing the pumping machinery for the new works has been awarded to the Buffalo (N. Y.) Steam Pump Co.

Wymore, Neb.—Bids for constructing works will be opened on Nov. 19. Engineer, A. A. RICHARDSON, of Lincoln.

Pawnee City, Neb.—The Buffalo (N. Y.) Steam Pump Co. has been awarded the contract for furnishing the pumping machinery.

SOUTHWESTERN.

Meridian, Tex.—The following information has been received from JOHN HARVEY:

Nothing definite has yet been done toward the construction of works. It is proposed to pump the supply from artesian wells to a stand-pipe. Address the Chairman of the City Council.

Colorado Springs, Col.—The City Council has sold $80,000 of new water bonds to N. W. Harris & Co., of Chicago, at $82,504.

New Castle, Col.—A. BONDMAN, Jr., has sent us the following:

The contracts for establishing works will be let about Dec. 1. The city will issue $15,000 of bonds, and own and operate the works. Water will be pumped from Elk Creek to a reservoir, and used for fire protection as well as domestic use. Engineer W. A. TRUMBOR, of Glenwood Springs. Population, 1,400.

PACIFIC.

Port Townsend, Wash.—Active operations have been begun by the Mount Olympus Water Co. toward the construction of new works. Its capital stock is $500,000. A. W. Bash has succeeded HENRY LUNDES as President. The company expects to have the new system in operation within one year. Meantime, the city will be supplied through the old company's mains.

Seattle, Wash.—Plans are to be prepared from surveys now being made by City Engineer, J. S. SCURRY for bringing the new supply from Rock Creek. BENEZETTE WILLIAMS, of Chicago, is Consulting Engineer.

Queen Anne, Wash.—A suburb, and probably a part of Seattle —A new 1,000,000 gall. engine is being added to the plant of the Union Water-Works Co. Other improvements will probably be made. Engineer THOMAS GOWAN.

Portland, Oregon.—The Committee on Construction has awarded the contract for preparing the foundation, etc., for the new pump to S. M. Smith at $2,924.50. For supplying manholes, air valves, blow-offs, gates, etc., to Wolfe & Zuicker.

Ashland, Ore.—Contracts for furnishing materials for the new works have been awarded as follows: 5,000 ft., No. 16, double-riveted, 10-in., pipe 58 cts. per ft. 5,000 ft., No. 14, double-riveted, 10-in., 67 cts. per ft.; 3,000 ft., No. 14, double-riveted, 10-in., 89½ cts., to W. W. Montague & Co., of San Francisco; 3,000 ft., 10-in., spiral-welded steel pipe, $1.17½; 8,000 ft., 8-in. spiral-welded steel pipe, $0.77½, to Coit, Barton & Cowles; 1,400 ft., 6-in. converse link joint, 80 cts. per ft.; 30,000 ft., 2-in., lap-welded, screwed pipe, 17½ cts., to the National Tube Works, of McKeesport, Pa. Total estimated cost of new works completed, $46,150 50.

Santa Cruz, Cal.—Land on which to construct the new reservoir has been purchased for $10,000. It will have an area of about 30 acres.

Santa Barbara, Cal.—An exhaustive report on a water supply for Santa Barbara, Cal., has recently been submitted to the city authorities by GEO. F. WRIGHT, C. E., of that city. Mr WRIGHT recommends the construction of a dam 100 ft. high on the Santa Ynez River and the necessary conduits to bring the water to the city. The following detailed estimate of cost gives a good general idea of the character of the plan recommended:

Dam and storage reservoir	$100,000
17,000 ft. of 24 in. pipe at $1.15	19,500
51,000 ft. of 18 in. pipe at $.75	38,625
6,000 ft. of tunnel at $10	60,000
Distributing dam and reservoir	40,000
Constructing roads, trails, etc	10,000
Real estate and water rights	15,000
Engineering and incidental expenses	15,000
Total estimated cost	$298,175.

Prior to Jan., 1889, the city was supplied by the Mission Water Co., whose works were built in 1830 by Franciscan monks; and by the De la Guerra Garden Spring Water Co., whose works were built in 1868. In Jan., 1889, these companies consolidated. The supply is inadequate, and the city proposes to construct works.

CANADA.

Chatham, Ont.—The city has signed a contract with the Drive Well Water-Works Co. for a system of works. An annual rental of $2,893 will be paid. The contract calls for a 200,000 gall. steel or iron tower, 12 miles of mains, and 15 hydrants.

Calgary, No. W. Ter.—A bill is before the Legislature at Regina, to incorporate the Calgary Water Power Co., Limited.

ARTESIAN WELLS.

Sea Isle City, N. J.—A 484 ft. well has been sunk by URIAH WHITE which has a capacity of 30 galls. per minute.

Huron, So. Dak.—The City Council has closed a contract with J. D. Howard to sink a 5½ in. well.

Faulkton, Dak.—A well is being sunk.

IRRIGATION.

Trinidad, Col.—Bids are wanted by C. M. PERRIN Engineer in charge, for constructing an earth dam across Cimarron River, near Folsom, N. M.

Piura, Peru, S. A.—The concession recently made by the Peruvian Government to Maj. ALFRED F. SEARS, of Portland, Oregon, authorizing the construction of a large irrigating system, has been confirmed by Congress. Water rents are made obligatory upon the people, and are secured by their crops. The work includes the construction of a dam 80 ft. high by 4,000 ft. long, by which is formed an artificial lake 18 miles long and 3 miles wide. This lake will be navigable and feed navigable canals to a point near the coast.

Marysville, Cal.—Bonds for $110,000 of the Browns Valley Irrigation District have been sold to San Francisco bankers at 10 per cent. discount. The investors live in Switzerland. The same parties have also invested $300,000 in Turlock Irrigation District bonds.

Salt Lake City, Utah.—The question of letting contracts for tunneling instead of the city doing the work has been discussed in council, and the matter referred to the Committee on Irrigation, with Engineer BROOKS associated.

Redwater, Dak.—The Redwater irrigating canal will be 16 ft. wide at the bottom and 4 ft. deep.

Santa Fé, N. M.—The Rio Grande Irrigation & Colonization Co. has closed negotiations for 1,200,000 acres of land on the Rio Grande River, and adjacent thereto, between Wallace and San Marcial, and surveys for a large canal have been commenced to extend from Santa Cruz to a point above Wallace.

Idaho.—The Snake River Land & Cattle Co. proposes to tap the Snake River at Story's Ferry, 6 miles from Minnidoka as a source of supply for an extensive irrigating plant.

Virginia City, Nev.—Work on the dam at the Washoe Lake outlet is being pushed forward rapidly. It is to be about 80 ft. long and 15 ft. high, and built of solid masonry.